JOURNAL OF GERONTOLOGY

VOLUME 14, NUMBER 4
OCTOBER, 1959

Section A

Biological Sciences and Clinical Medicine

JOURNAL OF GERONTOLOGY

VOLUME 14, SECTION A OCTOBER, 1959 NUMBER 4

AGE CHANGES IN THE CHEMICAL COMPOSITION OF MUSCLE AND LIVER IN THE RAT

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Reductions in the amount of functioning protoplasm in specific tissues have frequently been offered as an explanation for various physiological impairments of old age observed in the intact animal. Age-dependent losses in tissues composed of fixed postmitotic cells such as skeletal muscle are generally believed to be greater than in tissues such as liver where the cells retain regenerative potential. In this study the chemical composition, as well as the weights of liver and muscle, were determined to estimate the loss of functioning protoplasm of these tissues during aging.

MATERIALS AND METHODS

Animals. All rats were of the McCollum strain and were bred and maintained in our animal quarters. They were housed, 5 in a cage, on wood shavings in a room maintained at 75 ± 2 F. A standard stock diet (2) was fed *ad libitum*. All animals were unmated. In each experiment the various determinations were carried out on the tissues of 10 male and 10 female rats, aged 12-14 months and an equal number aged 24-27 months.

Preparation of Tissue Samples. The animals were stunned by a blow on the back of the neck and bled by cardiac puncture using an oiled syringe. The rats were then sacrificed by decapitation. The livers were removed immediately, trimmed of fat and extrinsic tissue, and placed in a chilled moist Petri dish. Total skeletal muscle was removed from the hip to the knee of the hind limbs, freed of visible fat and connective tissue, and accurately weighed. These thigh muscles were used for the chemical analyses. The gastrocnemius muscles were removed and placed in 10% neutral formalin for histological examination (1).

Chemical Analyses. All chemical analyses were carried out in triplicate. Total water was determined on 75 mg. of tissue, by drying to constant weight at 110 C. Neutral fat was then determined on the dried samples after extracting three times in diethyl ether for 36 hours. Nitrogen was determined on 250 mg. of tissue by the micro-Kjeldahl procedure of Hiller, Plazin, and Van Slyke (10). Determinations of chloride, phosphorus, sodium, and potassium were carried out on an accurately weighed tissue sample of approximately 3 Gm. The sample was first refluxed with concentrated nitric acid for three hours in the presence of a silver nitrate solution of known concentration and containing an excess of silver ion. After cooling to room temperature, the sample was diluted to 25 cm.^{3}. Chloride content was determined on an aliquot by the Volhard titrimetric method as modified by Lowry and Hastings (11). Another aliquot was digested completely by wet ashing with a mixture of nitric and sulphuric acids. Phosphorus was determined by the method of Sumner (15) and sodium and potassium by flame photometry (7). Water, sodium, and chloride (14) were determined on serum which had been separated from the red cells anaerobically. These serum analyses were used in the calculation of the extracellular phase of the tissues.

RESULTS

Body Weights and Tissue Weights. The reliability of the method used to obtain muscle samples was tested by comparing the tissue removed from each leg. The mean difference

Submitted for publication June 3, 1959.

The authors wish to express their gratitude to Mrs. Ramona Dorcas and Mrs. Janet Ellis for their able and competent assistance in performing the chemical analyses and calculations. We are also indebted to Dr. A. B. Hastings for his review of the data and his helpful suggestions.

TABLE 1. EFFECT OF AGE ON BODY WEIGHT, LIVER WEIGHT, AND MUSCLE MASS OF THE HIND LIMB OF MALE AND FEMALE RATS.

	Young	Old	Pdiff.
Males			
Body weight (Gm.)	469 ± 19.6	433 ± 8.2	NS
Liver weight (Gm.)	13.34 ± 0.82	13.05 ± 0.52	NS
Percentage of liver weight to body weight	2.85 ± 0.13	3.02 ± 0.13	NS
Muscle mass (Gm.)	28.05 ± 2.01	18.45 ± 1.83	.003
Percentage of muscle mass to body weight	5.87 ± 0.33	4.23 ± 0.31	.002
Females			
Body weight (Gm.)	242 ± 3.6	283 ± 9.2	.001
Liver weight (Gm.)	7.92 ± 0.22	9.42 ± 0.26	.001
Percentage of liver weight to body weight	3.28 ± 0.09	3.35 ± 0.10	NS
Muscle mass (Gm.)	14.56 ± 0.67	13.90 ± 0.50	NS
Percentage of muscle mass to body weight	6.03 ± 0.29	4.99 ± 0.18	.005

between the weight of the tissue from the left and right leg was + 0.0316 Gm. ($N = 37$, $\sigma_{mn.\ diff.} = 0.4007$ Gm., $t = 0.47$). Although the mean body weight and liver weight of the senescent male rats were slightly smaller than the younger animals', statistical significance could not be established (table 1). Similarly, the ratio of liver weights to body weights remained essentially unchanged with age. In contrast, a significant age-dependent decrement in the muscle mass of the thighs was observed. This decrease exceeded the loss of total body weight as indicated by a reduced ratio of this muscle mass to body weight. The mean body and liver weights of the older female rats were greater than those of the younger animals, so that a constant liver weight to body weight ratio resulted. Although reduction in the muscle mass of the hind limbs in the older female animals was not statistically significant, an age-dependent decrement in the ratio of muscle mass to body weight was significant.

Chemical Composition of Tissues

Muscle—Males. Since the fat content of the muscle was higher in the senescent than in the young animals (Young = 1.13 ± 0.10 Gm./Kg. and Old = 2.03 ± 0.24 Gm./Kg. for males, and Young = 1.29 ± 0.14 Gm./Kg. and Old = 1.66 ± 0.10 Gm./Kg. for females), all values reported in table 2 were calculated on a fat-free basis. A small increase in the total water content of muscle of old male rats as compared to the young animals was observed. The concentrations of the extracellular component, chloride, were also increased in the old animals. From these data and the concentration of chloride in the serum, the extracellular and intracellular water of muscle was calculated as described by Hastings and Eichelberger (9).* An age-dependent change in the distribution of water within the muscle occurred so that as the intracellular water (C_{H_2O}) decreased the extracellular water (C_{H_2O}) increased. The decrement associated with age in the intracellular water (5%) was approximated by decreases in the concentrations of the intracellular components: potassium, phosphorus, and nitrogen.

Muscle—Females. The age-dependent changes in the chemical composition of muscle tissue of female rats were slightly less than those in male animals but were in the same direction.

Liver—Males and Females. Although no age differences in the fat content of liver tissue were found, the chemical composition of this tissue was also calculated on a fat free basis (table 3). No changes associated with aging were found in the chemical composition of liver in either sex. Plasma sodium, rather than chloride, was used to calculate the extracellular water of liver since Manery (13) found that liver contains a

* Extracellular phase in Gm./Kg. muscle (E) = $\frac{\text{m.Eq. Cl/Kg. muscle}}{\text{mEq. Cl./Kg. serum } H_2O}$ x 95/99 x 100, $E_{H2O} = 0.99\ E$, C_{H2O} = Total H_2O in Gm. − E_{H2O}

TABLE 2. EFFECT OF AGE ON CHEMICAL COMPOSITION OF MUSCLE OF MALE AND FEMALE RATS. (based on fat-free weight)

	N	H_2O (Gm./Kg.)	Cl (mEq./Kg.)	E_{H_2O}[1] (ml./Kg.)	C_{H_2O} (/ml./Kg.)	K (mEq./Kg.)	P (mM/Kg.)	N (total) (Gm./Kg.)
Males								
Young	10	766.4 ± 1.46	13.3 ± 0.29	120.6 ± 1.11	647.0 ± 2.54	106.1 ± 1.34	75.4 ± 0.89	35.7 ± 0.30
Old	10	777.0 ± 1.27	17.5 ± 1.06	162.5 ± 9.94	616.2 ± 9.20	99.0 ± 1.65	69.1 ± 0.90	33.5 ± 0.40
$\frac{\text{Young-Old}}{\text{Young}} \times 100$		—	—	—	5	7	8	6
$P_{diff.}$		.001	.001	.001	.005	.004	.001	.001
Females								
Young	10	767.8 ± 1.07	13.6 ± 0.51	125.0 ± 4.72	644.1 ± 5.41	106.1 ± 0.68	74.5 ± 0.74	35.9 ± 0.20
Old	10	772.0 ± 1.76	15.3 ± 0.36	144.7 ± 3.25	628.8 ± 2.81	102.0 ± 1.70	70.8 ± 0.92	34.9 ± 0.20
$\frac{\text{Young-Old}}{\text{Young}} \times 100$		—	—	—	3	4	5	3
$P_{diff.}$		.07	.015	.003	.02	.04	.015	.001

[1] Mean serum Cl values (mEq./L.) with $\sigma_{mn.}$ for young and old males were 95.2 ± 1.05 and 93.8 ± 1.09, respectively; for young and old females, 93.2 ± 0.82 and 91.2 ± 0.65, respectively.

TABLE 3. EFFECT OF AGE ON CHEMICAL COMPOSITION OF LIVER IN MALE AND FEMALE RATS. (based on fat-free weight)

	N	H_2O (Gm./Kg.)	Na (mEq./Kg.)	E_{H_2O}* (ml./Kg.)	C_{H_2O} (ml./Kg.)	K (mEq./Kg.)	N (total) (Gm./Kg.)
Males							
Young	10	718.6 ± 3.13	31.4 ± 0.86	171.9 ± 6.06	548.4 ± 6.72	96.7 ± 1.81	31.4 ± 0.70
Old	10	723.1 ± 1.69	33.2 ± 1.16	183.8 ± 6.88	540.8 ± 6.11	95.0 ± 0.63	30.7 ± 0.30
$P_{diff.}$		NS	NS	NS	NS	NS	NS
Females							
Young	10	715.1 ± 1.87	30.9 ± 1.02	177.6 ± 6.03	539.3 ± 5.54	95.2 ± 1.27	31.2 ± 0.30
Old	10	722.1 ± 3.14	32.7 ± 0.52	183.2 ± 3.04	540.8 ± 2.91	92.4 ± 2.08	30.3 ± 0.50
$P_{diff.}$		NS	NS	NS	NS	NS	NS

* Mean serum Na values (mEq./L.) with $\sigma_{mn.}$ for young and old males were 157.9 ± 2.41 and 157.7 ± 0.93, respectively; for young and old females, 150.1 ± 1.33 and 153.7 ± 1.30, respectively.

greater amount of chloride than can be explained on the basis of the extracellular fluid calculated from the sodium content.

DISCUSSION

The apparent loss in body weight of the old male rats is in agreement with the data of Berg (5), Bourlière (6), and Everitt (8). The lack of a similar age decrement in the body weight of the female rats of this study may be explained by (a) the observations of Everitt (8) indicating that death in aged rats is preceded by a period of body weight loss and (b) the greater longevity of females as compared to male rats (5).

The changes in the total liver weights of these animals were found to be essentially proportional to the changes in the body weights. In contrast, the muscle mass of the thighs of aged rats of both sexes was not only decreased but the loss of muscle tissue was greater than the changes in body weight. In order to determine whether the age-dependent loss of muscle tissue could be demonstrated in a specific muscle, 20 male and 20 female rats, equally divided between the two age groups previously used, were sacrificed and the gastrocnemius was carefully removed and weighed. The mean weights and the standard error of the means for young and old male rats were 2.47 ± 0.08 Gm. and 2.05 ± 0.08 Gm., respectively, and 1.42 ± 0.04 Gm. and 1.29 ± 0.04 Gm., respectively, for young and old female rats. In this experiment, no significant age-dependent loss of liver weight was observed in either sex.

Chemical analyses of muscle demonstrated an

age-dependent increase in the extracellular components and a decrease in the intracellular components. These results are in agreement with the findings of Lowry and associates (12). The concentrations of phosphorus and potassium (76.3 mM/Kg. and 110.6 mEq./Kg., respectively) found in the tissues of the younger animals (604 days—Yale Cornell strain) used by these investigators were essentially equal to those of the young animal in the present study. However, a greater age decrement (9%) was observed by Lowry and Hastings (12) using 988-day-old rats. One male and one female 33-month-old rat, available at the time of this study, were sacrificed and the tissue analyzed. The results indicated that phosphorus and potassium were decreased 20 and 25%, respectively, in the male and 9 and 9% respectively, in the female. Although the small number of 33-month-old rats available to us and the lack of information regarding the sex of the animals used by Lowry and Hastings (11) do not make possible direct comparisons, these results indicate that a greater amount of muscle tissue is lost in 33-month-old rats than in 24-month-old animals. It is interesting that the various changes observed in muscle were greater in the male than the female animals. This finding is compatible with the greater frequency and more extensive morphological changes found in the skeletal muscle of old males than in old female rats (1, 4).

The uniformity of the percentage losses of the intracellular components, which approximated the loss of intracellular water of muscles of aged rats, indicates that the intracellular concentrations of this tissue remains essentially unchanged during aging. This inference is substantiated by the lack of an age-dependent difference in the ratios of the various intracellular components shown in table 4. Further evidence relating to the constancy of the intracellular environment irrespective of age or sex can be found in the cell water concentration. Water per kilogram of cells was calculated by assuming that the weight of the extracellular phase per kilogram of tissue consisted of 1 Gm. of salts and 13 Gm. of collagen plus elastin in addition to the extracellular water. A value of 748 Gm. of water per Kg. of cells was obtained for each of the 4 groups of animals. Again, these results agree with the findings of Lowry and Hastings (12), who demonstrated a uniform concentration of potassium and phosphorus per unit of cellular water, as well as a constant cell water

TABLE 4. RATIOS OF CELLULAR COMPONENTS OF RAT MUSCLE.

	Young	Old	$P_{diff.}$
Males			
$\frac{\text{N (Gm.)}}{\text{P (Gm.)}}$	15.24 ± 0.20	15.73 ± 0.19	NS
$\frac{\text{K (mEq.)}}{\text{N (Gm.)}}$	3.01 ± 0.05	2.93 ± 0.04	NS
$\frac{\text{K (mEq.)}}{\text{P (Gm.)}}$	45.74 ± 0.58	46.10 ± 0.50	NS
Females			
$\frac{\text{N (Gm.)}}{\text{P (Gm.)}}$	15.53 ± 0.12	15.42 ± 0.52	NS
$\frac{\text{K (mEq.)}}{\text{N (Gm.)}}$	2.96 ± 0.02	2.92 ± 0.05	NS
$\frac{\text{K (mEq.)}}{\text{P (Gm.)}}$	45.89 ± 0.51	46.36 ± 0.73	NS

value per Kg. of cells. These results indicate that senescence is accompanied by either (a) atrophy of the muscle fibers or (b) a loss of the fibers. Since a preferential loss of cellular elements in proportions necessary to maintain a uniform intracellular composition with respect to nitrogen, phosphorus, and potassium seems unlikely, it is believed that fewer cells are present in the existing muscles of aged rats. Histological examinations carried out on muscle sections from these same animals substantiate this interpretation (1).

No age differences in the chemical composition of liver tissue were observed. These data are in accordance with our previous report indicating a lack of an effect of age on certain overall metabolic activities and on the concentrations of various enzymes and desoxyribose nucleic acid of liver tissue obtained from these same animals (3).

The results are compatible with the concept that aging is accompanied by a loss of cells that are replaced by extracellular components in tissue composed of fixed postmitotic cells in contrast to tissues which retain regenerative potential.

SUMMARY

A comparison of age changes in the mass and chemical composition of muscle, a tissue composed of fixed postmitotic cells, and liver, a tissue which retains regenerative potential, has been made in 40 rats. Age decrements in the muscle mass of the thighs but not in the weight of liver were observed. No significant age changes were found in total water, fat, potas-

sium, or sodium content of liver. In muscle the intracellular water and intracellular components, nitrogen, potassium, and phosphorus, decreased significantly in the old animals. The uniformity of the percentage losses of these intracellular components suggests a loss of muscle fibers during aging.

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CORRELATION OF AGE CHANGES IN HISTOLOGICAL AND CHEMICAL CHARACTERISTICS IN SOME TISSUES OF THE RAT*

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Two kinds of tissues in the rat, liver parenchyma and skeletal muscle, show a contrasting behavior of the ratio of extracellular water to total water with increasing age, according to the findings of Yiengst, Barrows, and Shock (14). No significant change is seen in liver, while the ratio is significantly increased in skeletal muscle. The total water content is unaffected by age in both tissues. The intracellular components, (N, K, and P) show no significant change with age in the liver but a significant decrease in skeletal muscle. According to the authors the results are compatible with the concept that aging is accompanied by a loss of cells that are replaced by extracellular components in fixed post-mitotic tissues in contrast to tissues which retain regenerative potential.

The object of the present investigation was to determine by histological study whether a correlation of the microscopic picture at various ages with the biochemical findings for those ages could be made. The present study reports histological findings in the muscles and liver of the same rats that were analyzed chemically by Yiengst, Barrows, and Shock (14).

MATERIALS AND METHODS

Histological preparations of skeletal muscle and liver were made from 40 animals used in the biochemical study (14). The quantitative histological study and counts have been made on sections from 12 animals selected at random. The same livers which had been studied biochemically were examined histologically. The muscle sections were prepared from the calf of the same rats from which the thigh muscles were used in the chemical study. The animals used in the quantitative work varied in age from 14 to 33 months (tables 1-5). The sections from the remaining animals of the original group of 40 were studied in a qualitative way and served to supplement the observations on the general histological appearance in those on which the more detailed study and correlations were made.

The tissues were removed from the animals as soon after death as possible and fixed in 10% neutral formalin. They were dehydrated in alcohols of increasing strength, cleared, infiltrated, and embedded in paraffin. The processes of dehydration and infiltration were carried out in a Lipshaw automatic tissue processor, the pieces of liver of all of the animals being carried through at one time and those of muscle at another, thus insuring uniformity of treatment of the tissue from the animals of different ages.

The sections were cut at 6μ and stained by two methods: 1) Ehrlich's hematoxylin and eosin, and 2) Masson's Trichrome Stain for the connective tissues.

The sections were surveyed with the low power (100 diameters) for the general appearance of the tissue and for evidence of loss of parenchyma and of possible replacement by other types of tissue. Higher magnifications were used, including oil immersion (970 diameters), for the study of the manner of degeneration of parenchyma, the occurrence of aggregations of lymphoid tissue and of mast cells, and the determination of types of replacing tissue.

In order to arrive at a quantitative statement of the histological changes, three sections of skeletal muscle and three sections of liver from each animal were studied. In the case of the skeletal muscle, the complete width of the muscle section at its central portion and in two other locations, 500μ from either extremity of the section, were observed. The percentage of muscle tissue greatly altered or apparently replaced by other tissue, in relation to the number of striated fibers, was estimated in each section (table 1). This method is not quantitatively exact in the sense in which the biochemical data are, but it did seem a useful one for such histological study on loss of protoplasmic units.

Submitted for publication June 3, 1959.

* This study was supported in part by a grant from the National Heart Institute, H-4330, for which grateful acknowledgment is made.

Tables 1 and 2 also show the extracellular water content (expressed as percentage of total water of the muscle) and the concentration of intracellular K, expressed as mEq. per Kg. fat free wet weight (14).

In the case of the liver, three entire sections, each approximately 5 × 11 mm., were studied and the percentage of parenchyma replaced by other tissue again was recorded (table 2).

RESULTS

The reliability of the histological evaluations was tested by making a second independent observation of one section of muscle from each animal. The results are shown in table 3. The mean difference between the two sets of observations was 2.3 with a standard deviation of 3.2. Although some animals showed erratic distribution of degenerative changes, mean values obtained in the duplicate series were not significantly different.

The phenomenon of localized loss of skeletal muscle fibers does not seem to be entirely confined to the older rats in this series, as one of the 4 younger animals, a 14-month female, showed some loss. The loss in the older rats (table 1) is, however, marked, and the high percentages, such as 16.68 in the 26-month male, 10.22 in the 33-month female, and 28.06 in the 33-month male, make the histological changes in this tissue as noteworthy as are the biochemical alterations, such as increase in percentage of extracellular water and decrease in amount of the cellular components. Statistical analysis of the data shows a very high positive rank order correlation (p) between the number of tissue units lost, as arrived at by our histological observations, and the proportion of the extracellular water ($p = 0.97$, table 1). The rank order correlation between the potassium content of muscle tissue and histological estimates of tissue loss was –0.73 (table 1). The replacing elements apparently are of such a nature that protoplasm forms only a very small proportion of their bulk. Chemically, they can be thought of as representing extracellular or at least "extraprotoplasmic" material. Histological observation gives support to this view, as the portions

TABLE 1. CORRELATION OF BIOCHEMICAL AND HISTOLOGICAL FINDINGS IN A TISSUE COMPOSED OF FIXED POST-MITOTIC UNITS (SKELETAL MUSCLE). DATA ON ALBINO RATS OF THE MCCOLLUM STRAIN.

Identification of Animal	Age (in Months) & Sex	Tissue Units Lost or in Process of Destruction Expressed in % of Original Numbers (by Histological Examination)	Extracellular Water Expressed in % of Total H_2O Biochemical Data	Cellular Components K mEq/Kg. fat-free wet wt.
4A	14F	4.24	20.62	107.5
6A	14M	None	16.40	107.6
36A	16F	None	17.43	105.2
30A	16M	None	15.56	99.9
7A	25F	1.23	19.12	107.8
37A	25M	0.14	16.78	104.0
15A	26F	2.15	17.85	106.0
13A	26M	16.68	27.70	91.5
27A	27F	None	16.19	99.9
25A	27M	8.45	23.12	97.0
42A	33F	10.22	22.04	92.08
41A	33M	28.06	38.57	80.0

Coefficient of Correlation of Tissue Units Lost and % of Extracellular Water ..... +0.97

Coefficient of Correlation of Tissue Units Lost and Quantity of Cellular Components ..... —0.73

TABLE 2. CORRELATION OF BIOCHEMICAL AND HISTOLOGICAL FINDINGS IN A TISSUE COMPOSED OF REVERSIBLE POST-MITOTIC UNITS (LIVER). DATA ON ALBINO RATS OF THE MCCOLLUM STRAIN.

Identification of Animal	Age (in Months) & Sex	Cellular Units Lost or in Process of Destruction Expressed in % of Original Numbers (by Histological Examination)	Extracellular Water Expressed in % of Total H_2O	Cellular Components K mEq/Kg. fat-free wet wt.
4A	14F	None	24.63	96.3
6A	14M	None	25.38	101.9
36A	16F	None	24.59	95.1
30A	16M	None	27.87	101.8
7A	25F	None	26.13	81.3
37A	25M	None	27.56	99.08
15A	26F	None	24.94	83.0
13A	26M	None	23.49	95.39
27A	27F	None	24.36	94.7
25A	27M	None	26.45	93.42
42A	33F	None	25.64	92.8
41A	33M	None	28.99	98.40

Coefficient of Correlation of Tissue Units Lost and % of Extracellular Water 0.0

Coefficient of Correlation of Tissue Units Lost and Quantity of Cellular Components 0.0

TABLE 3. COMPARISON OF TWO ESTIMATES OF TISSUE LOSS IN SKELETAL MUSCLE OF YOUNG AND OLD RATS.

Identification of Animal	Age (in Months) & Sex	Tissue Units Lost or in Process of Destruction Expressed in % of Original Numbers	
		First Estimate	Second Estimate
4A	14F	4.24	2.97
6A	14M	None	None
36A	16F	None	None
30A	16M	None	None
7A	25F	1.23	1.11
37A	25M	0.14	None
15A	26F	2.15	0.84
13A	26M	16.68	11.74
27A	27F	None	None
25A	27M	8.45	1.38
42A	33F	10.22	7.32
41A	33M	28.06	18.11

Mean diff. (1st estimate-2nd estimate) = 2.3
σ mean diff. = 3.2
t = 0.6

of the muscle no longer occupied by striated fibers are filled in either by fibrous connective tissue with only a few attenuated fibroblasts or by a mature type of adipose tissue in which the cytoplasm and nuclei of the fat cells are very inconspicuous (table 4 and figs. 1, 3 and 4).

The actual manner of degeneration of the striated fibers seems to follow a rather constant pattern. In those parts of the muscle showing early change, the numbers of nuclei are increased. They show a characteristic arrangement in long rows, sometimes involving 30 or 40 nuclei, which seem to be in contact with each other at their extremities (fig. 2). The manner of increase is not clear. We did not find mitotic figures and amitosis seems to be a probable explanation.

The nuclei seldom show any signs which could be interpreted as degenerative change. Occasionally very much elongated nuclei are seen, 4 or 5 times as long as the average nucleus. Such nuclei might result from fusion of individual nuclei formed by amitotic division but remaining in contiguity.

The sarcoplasm itself shows marked degenerative changes, with fragmentation of the fibers and decrease in size and disappearance of the fragments. In some areas the fibers seem to lose their striations before the process of fragmentation occurs but in others striation may be retained even in very small fragments of cytoplasm (fig. 3).

Although the process seems to be a frankly destructive one, there is a lack of leucocytic reaction. There are no conspicuous aggregations of polymorphonuclear leucocytes nor of lymphocytes (table 4). A few lymphocytes occur in the connective tissue but they do not seem more abundant in the areas where the muscle tissue is degenerating than where it is not. We have not seen any evidences of phagocytosis of the cellular debris by macrophages or other cells.

TABLE 4. HISTOLOGICAL FEATURES AT DIFFERENT AGES IN A TISSUE COMPOSED OF FIXED POST-MITOTIC UNITS (SKELETAL MUSCLE). DATA ON ALBINO RATS OF THE MCCOLLUM STRAIN.

Identification of Animal	Age (in Months) & Sex	Amount of Loss of Protoplasmic Units (% of original)	Type of Replacing Tissue	Mast Cells	Lymphocytic Infiltration		
					None to Minimal	Moderate	Marked
4A	14F	4.24	Fibrous connective tissue	Few	+		
6A	14M	None	None	Few	+		
36A	16F	None	None	Few	+		
30A	16M	None	None	Moderate	+		
7A	25F	1.23	Fibrous connective tissue	Many	+		
37A	25M	0.14	Fibrous connective tissue	Few	+		
15A	26F	2.15	Fibrous connective tissue	Few	+		
13A	26M	16.68	Fibrous connective tissue and adipose tissue	Many	+		
27A	27F	None	Fibrous connective tissue	Many	+		
25A	27M	8.45	Fibrous connective tissue and adipose tissue	Many	+		
42A	33F	10.22	Fibrous connective tissue and adipose tissue	Many	+		
41A	33M	28.06	Fibrous connective tissue and adipose tissue	Many	+		

Fig. 1. from a 33 and invas X138.

Fig. 3. bundle o ments of tissue. O tains its

Fig. 1. Three bundles of degenerating muscle tissue from a 33-month-old male rat. Fragmentation of fibers and invasion of the bundles by adipose tissue are seen. X138.

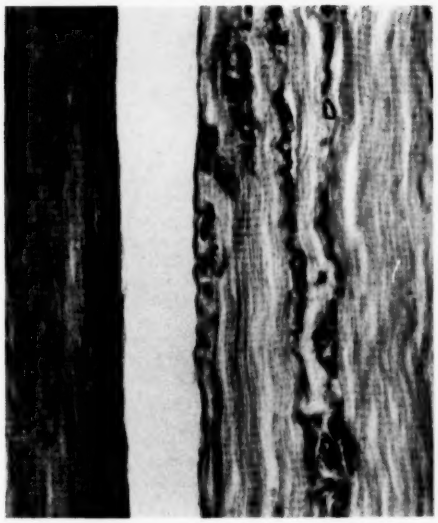

Fig. 2. Early stage of degeneration of fibers (right) in a 33-month-old female rat. There is an increase in number of nuclei which tend to be arranged in long rows. On the left are normal fibers. X570.

Fig. 3. Advanced stage of degeneration in a muscle bundle of a 33-month-old male rat. Several large fragments of fibers are seen among the replacing connective tissue. One of the small masses of muscle cytoplasm retains its striation. X570.

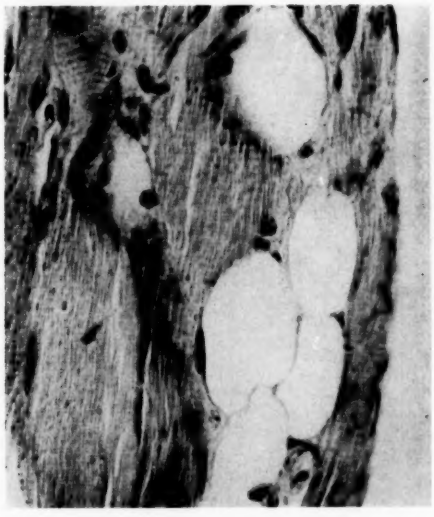

Fig. 4. Adipose tissue invasion in a muscle bundle of a 33-month-old female rat. The fat cells are very intimately related to the muscle fibers, and it is not by any means always possible to tell whether such invasion precedes muscle degeneration or follows it. X570.

Fig. 5. Mast cell on muscle fiber in a 33-month-male rat. These cells are increased in number in the muscle of older rats and are particularly conspicuous in areas where degenerative change is beginning. X570.

Fig. 6. Origin of a vacuole in the media of an artery in the muscle of a 25-month-old female rat. These vacuoles, a conspicuous feature in arteries of the muscles in older rats, are here seen to have their origin within cells of the smooth muscle. X1995.

TABLE 5. HISTOLOGICAL FEATURES AT DIFFERENT AGES IN A TISSUE COMPOSED OF REVERSIBLE POST-MITOTIC UNITS (LIVER). DATA ON ALBINO RATS OF THE MCCOLLUM STRAIN.

Identification of Animal	Age (in Months) & Sex	Amount of Loss of Protoplasmic Units (% of original)	Mast Cells	Lymphocytic Infiltration		
				None to Minimal	Moderate	Marked
4A	14F	None	Absent	+		
6A	14M	None	Few	+		
36A	16F	None	Absent	+		
30A	16M	None	Absent	+		
7A	25F	None	Moderate numbers		+	
37A	25M	None	Absent	+		
15A	26F	None	Absent	+		
13A	26M	None	Absent		+	
27A	27F	None	Absent	+		
25A	27M	None	Absent		+	
42A	33F	None	Absent			+
41A	33M	None	Absent			+

Fig. 7. Liver parenchyma of a 33-month-old female rat. The cells of such parenchyma generally appear normal and very similar to those of younger animals. X1352.

Fig. 8. An area of liver parenchyma in a 33-month-old female rat in which some cells show vacuoles indicative of fat storage. Such accumulation of fat does not seem to affect the cell in a deleterious manner. Masson's stain. X1352.

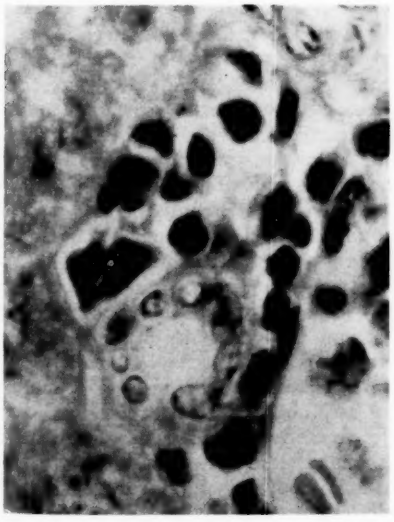

Fig. 9. Portal area of a 33-month-old female rat. Lymphocytic infiltration, a common phenomenon in the liver of old animals, is seen about the bile duct (left) and between it and the branch of the portal vein (right). X1352.

Fig. 10. Aberrant type of cell in the liver of a 33-month-old male rat. Such very large cells occur relatively frequently in the livers of old animals as compared with those of young and middle-aged ones, yet even in senile animals, they are scattered rather sparsely among the normal cells. X1352.

The mast cells, however, seem to be related in some way to the muscle degeneration. These cells are definitely more abundant in the muscles of the older animals and in addition show an apparent affinity to areas of degenerating fibers, often lying in close contact with such structures (fig. 5). Whether such contact might be due to shifts in position dependent simply on decreased volume of the fibers or whether the mast cells actually are attracted to degenerating tissue, perhaps to perform some unknown function, is not known.

The blood vessels in the muscles studied did not seem to be the site of arteriosclerotic changes, but one type of alteration was seen in many of the medium-sized and small vessels in the older rats. This consists in the presence of many vacuoles in the media. Our first observations did not make it clear to us whether these vacuoles were arising extracellularly or within connective tissue or smooth muscle. Closer study led to the finding of favorable areas where the origin of such vacuoles can be proved beyond doubt to be within the cells of smooth muscle (fig. 6).

Histological study of the liver in this series of rats shows relatively little age change in the organ and in particular little evidence of loss of parenchyma (table 5). The major part of each section presents cells of normal appearance (fig. 7), essentially similar to those seen in young animals. In some areas cells or groups of cells show vacuolation, evidently an indication of fat storage (fig. 8). The three animals in which this feature was most conspicuous histologically (6A, 13A, and 25A) turned out to be those in which a higher fat concentration had been found in biochemical analysis of these same livers. Since one of these is a young (14-month) animal, since the fat content either by biochemical or histological study (as evidenced by vacuolation) did not increase consistently with age, and since vacuolation was not a feature in the livers of the two oldest animals, increase in fat storage cannot be described as a characteristic of age in this series.

Of frequent occurrence in the liver of the older rats is the phenomenon of periportal infiltration, an accumulation of lymphocytes, often intermixed with what seem to be reticular fibroblasts and possibly other cell types in the connective tissue about the bile duct and the branches of the portal vein and hepatic artery (fig. 9).

Present also in the old livers, although usually small in numbers and widely scattered, are certain very large cells of the parenchyma with concomitantly large nuclei (fig. 10). The nuclei of such cells generally show many nucleoli.

DISCUSSION

The most important conclusion from this study is that in some tissues it is possible to correlate the biochemical and histological changes occurring during the aging process. Such a correlation serves to clarify and make more significant each of the two types of data.

The histological observations on skeletal muscle and liver which we have described constitute an affirmation of the correctness of the theoretical statement of Yiengst, Barrow, and Shock, mentioned at the beginning of this paper, in which they point out the compatibility of their biochemical findings with a concept that in fixed post-mitotic tissues aging is accompanied by a loss of cells which are replaced by extracellular components, while in tissues of the reversible post-mitotic type such a loss does not occur or is negligible.

It is true that the present study is only a sampling, employing two such contrasting tissues, but the correlation of the two types of data is indeed a close one.

The subject of water content of organs and tissues as related to age is one which has received considerable attention. Much of the work here, as with other variables, has concerned changes occurring in the earlier part of the life history or at least not going beyond the period of maturity. Thus, Hines and Knowlton (9) studied the water content of skeletal muscle of the rat, using animals ranging from 15 to 336 days of age. They obtained very constant figures for the water present within individual fibers (intracellular water) but found a decreasing proportion of water outside of the fibers (extracellular water). Yannett and Darrow (13) had found a similar change in skeletal muscle of young and of mature cats. Their histological studies showed an increase in size of the individual muscle fibers with a relative decrease in the volume of the space between the fibers (extracellular space). They concluded that the new cytoplasm added to the fibers is of composition very similar to that already present. A similar but considerably less marked decrease in extracellular fluid seemed to occur in the liver and brain of the cat, without alteration in the fluid content per cell.

Not only in skeletal muscle but also in cardiac muscle have such findings been made. Hastings and associates (8) studied heart muscle of puppies and of adult dogs. Here again, there was a decrease in the amount of extracellular fluid while the proportion of substance of the fibers as compared to that between the fibers was increased. The water content per unit weight of protoplasm of the fiber seemed to remain essentially constant.

The direction of change in these studies is, of course, the reverse of that found in the present work. Concerning as they do the change from the immature to the adult stage, they help to complete the picture of alteration in amount of extracellular water through the life span. They indicate also the essential constancy of the composition of the muscle fibers themselves and tend to show that changes in the proportion of extracellular and intracellular water are due to changes either in size or number of protoplasmic units rather than to change in composition of the individual units. There are studies also which concern the relation of extracellular to intracellular water in the passage from middle age to old age. Lowry and associates (11) compared muscle tissue, both skeletal and cardiac, from rats of middle age (603 days) and senile rats (988 days). They found that the extracellular fluid had almost doubled in the old rats. This is the reverse of the change seen from birth to maturity and a direction of change the same as in our own study. One animal in our series (table 1), the 33-month-old male animal, actually did have double the amount of extracellular fluid found in the young adults. Lowry and associates (11) believe that no essential change had taken place in the water-content of individual fibers in old age. On the other hand, little or no changes in the proportion of extracellular to intracellular mass in liver and brain were found with increasing age (12).

The process of degenerative alteration of the skeletal muscle is very similar to that described by Berg (6). In a large series of Sprague-Dawley rats (568 animals) he found a process of muscle deterioration, particularly marked in the hindlegs. Distribution of the lesions, as in our animals, was patchy with marked variation in extent and in degree of involvement. The changes included fragmentation and disintegration of the cytoplasm of the fibers, with some instances of infiltration by adipose tissue. The nuclei often showed evidence of multiplication and were arranged in long rows, as in our material. Berg observed nuclei in mitosis, a finding which we have not been able to make, interpreting some portions of the picture which he describes as representing attempts at regeneration.

The greater degree of change which he found in males than in females is seen also in our data. Berg does not mention an increase in number of mast cells in relation to the degenerating muscle. In our material this was a rather constant, although not a conspicuous, finding. One of us has found an increased tendency to infiltration by mast cells in the parotid glands of rats in old age (2), where degeneration of cellular elements also is occurring.

It is noteworthy that neither in Berg's nor the present study was evidence of an inflammatory reaction in the muscle found; the accumulations of lymphocytes, described earlier (3) as occurring in old age in various organs of the mouse, rat, and man, were conspicuously lacking in the skeletal muscle tissue. That such accumulations do occur in skeletal muscle in various pathological conditions is well known, and they have received a special name, the lymphorrhages. It was thought at one time that they were a phenomenon specific for cases of myasthenia gravis (1, 7) but they have been shown to occur in many other pathological conditions.

In relation to the histological observations on the liver in the older animals, we arrive at two conclusions 1) some age differences do occur and 2) these differences are not, in general, of a type leading to loss of cells. They consist primarily in a greater variation in size and appearance of hepatic parenchymal cells and in the occurrence of periportal infiltration. These features resemble those described in the liver in old age in the mouse and human being (5).

Among the most interesting histological findings made in the present study is that of the nature of the vacuolation often seen in the media of arteries of old rats. This phenomenon seems to have been described only twice previously (4, 10), and these previous reports did not give an indication of the tissue which is the site of origin of the vacuoles. The favorable material for study in the present series shows clearly that the vacuoles originate within individual cells of smooth muscle (fig. 5).

SUMMARY

Skeletal muscle, a tissue composed of irreversible post-mitotic units, shows a considerable degree of loss of such units in old age in 40 McCollum rats. The degree of loss of protoplasmic units, as determined by histological study, shows a close positive correlation with the increase of the proportion of extracellular water to total water and a close negative correlation with the quantity of intracellular constituents.

Liver, a tissue compound of reversible post-mitotic units, shows evidence of little or no loss of such units in old age. In correlation with this histological finding, the proportion of extracellular to total water and the quantity of intracellular components show no consistent change in this organ.

The qualitative features of the degenerative change in skeletal muscle are described.

Age differences in the histological picture of the liver are present, although in general they are not such as to bring about loss of parenchyma.

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THE EFFECT OF PITUITARY GROWTH HORMONE ON THE AGING MALE RAT*

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The relationship between growth and aging has been recognized for many years and has been discussed in reviews by various authors (3, 7, 23, 25, 32, 33, 34). The idea that senescence is due to the cessation of growth (23, 24) arose out of the work of Minot (27), which drew attention to the rapid decline in the rate of growth with age. A number of workers (1, 17, 30, 31) have observed that the longer the process of growth continues, the greater is the duration of life.

In the male rat growth ceases in middle age and is followed by a period of weight loss, which is terminated by death (12, 13). The purpose of the present investigation is to determine 1) whether treatment with pituitary growth hormone would stimulate the waning growth process in the middle-aged rat, and 2) if the period of growth were prolonged by this means, whether it would delay senescence and so increase the life duration.

MATERIALS AND METHODS

Animals used in this study were male rats of a non-inbred Wistar strain, which were housed in a small air-conditioned room (25 ± 1 C. and 55 ± 10% relative humidity) and fed a pelleted diet as described previously (17). Rats were weighed on an Ohaus sliding weight animal balance, at weekly intervals from weaning until natural death. The relative weight increment between the ages of 300 and 400 days, $\frac{W400 - W300}{W400}$ was determined. Animals were grouped according to this weight increment, which is directly correlated with life duration in the male rat (17). Rats which failed to gain weight between 300 and 400 days were discarded, because their life expectancy was considerably less than the average.

In a preliminary experiment 15 rats were treated with small doses of growth hormone and 15 control rats with saline. Rats were carefully arranged into pairs on the basis of their relative weight increments, and then one rat from each pair was selected at random for treatment with growth hormone. Pituitary growth hormone was injected intraperitoneally, once a day for 6 days per week, between the ages of 400 and 600 days. The dose of growth hormone was raised progressively by 0.2 mg. each 20 days from 0.2 mg. per day at 400 days to 2 mg. per day at 600 days. Each rat received a total of about 200 mg. of growth hormone during this period. Control animals received daily injections of 1 ml. of 0.9% NaCl adjusted to pH 9, instead of growth hormone. Growth hormone solutions were prepared immediately before use, by dissolving the required weight of Antuitrin Growth (Parke, Davis & Co.) in 0.9% NaCl adjusted to pH 9 and at a temperature of 37 C. The average assay value of Antuitrin Growth preparations was 2000 Rat Units per gram.

In a second experiment in which large doses of growth hormone were used, 10 rats were assigned at random to growth hormone treatment and 10 to saline treatment. As in the small dosage experiment rats were matched on the basis of their relative weight increments before assigning at random to treatment groups. The dose of growth hormone was raised progressively by 1.0 mg. each 14 days from 1 mg. per day at 400 days to 15 mg. per day at 600 days. Each rat received a total of about 1000 mg. of growth hormone during the period of treatment.

Using methods described in greater detail elsewhere (14, 15, 16, 18) metabolic, excretory, hematologic, and electrocardiographic studies were performed on these rats in young adult life before treatment was commenced, in middle age during treatment, and in old age about 100 days after the discontinuation of treatment.

For metabolic and excretory studies rats were placed individually in metabolism cages and after a 2-day period of adaptation the con-

Submitted for publication December 29, 1958.

* This investigation was supported in part by a grant from the Consolidated Medical Research Fund of Sydney University.

The pituitary growth hormone (Antuitrin Growth) used in this study was generously donated by Parke, Davis and Co. of Detroit, through the courtesy of Dr. D. A. McGinty.

The author is grateful to Dr. P. I. Korner for many helpful suggestions in the preparation of this manuscript.

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sumption of food and water and the production of feces and urine were determined over a 24-hour period. Urinary creatinine was determined by the alkaline picrate method of Folin (19), uric acid by the arsenophosphotungstate method of Benedict and Franke (4), and protein by the trichloracetic acid turbidometric method (22).

Blood was collected from the tail of the rat for the estimation of hemoglobin by the oxyhemoglobin technique (37), the red cell count by a turbidometric method (18), and hemocytometer counts of eosinophils using Manners' fluid (26) and of white cells using 0.5% acetic acid solution colored with methyl violet as diluent.

The electrocardiogram of the rat in the supine position was recorded under light pentobarbital anesthesia on a Cardiotrace direct writing electrocardiograph (Philip's Electrical Industries, Sydney). Measurements were made of heart rate and of the magnitude (20) and direction (21) of the mean QRS vector in the frontal plane.

During the period of treatment with large doses of growth hormone, additional studies were made of systolic blood pressure, fasting blood sugar, and fasting blood cholesterol, using methods described respectively by Byrom (5), Somogyi (36), and Day and Bolliger (9).

When a lifelong study is made of a group of individuals, the loss by death of the shorter-lived members progressively alters the composition of the group and therefore distorts the results in middle age and old age. This error was overcome in three ways. First, in order to study the effect of growth hormone on the age change in the body weight of the whole group (table 1), the mean weights were calculated from the weights of the surviving rats and the cumulative weight of dead rats (12, 38). Second, the effect of growth hormone on body weight in middle age was studied in a group of rats surviving beyond 700 days of age (fig. 2) in order to reduce the error due to the premortal loss of weight. Third, in most studies of body function (tables 4, 5, 7) a statistical technique was used to correct for the absence of data in old age from 4 growth-hormone-treated and 2 control rats, which died before determinations were made. The same method was used in correcting for rejected data on a growth-hormone-treated rat which developed a large mammary tumor in old age. The technique employed in these corrections was the analysis of variance for disproportionate class numbers as described by Snedecor (35).

The analysis of covariance (35) was used in many cases to make allowance for initial differences between control and growth hormone groups.

RESULTS

Body Weight.—In table 1 the mean body weights of growth-hormone-treated rats before treatment (at 300 and 400 days), during treat-

TABLE 1. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE AT 2 DOSAGE LEVELS, DURING THE PERIOD FROM 400 TO 600 DAYS OF AGE ON THE MEAN BODY WEIGHT OF MALE RATS AT VARIOUS AGES.

Experiment	Group (No. of Rats)	Body Weight (Gm.) ± S.E at							Maximum Weight (Gm.)
		300 Days	400 Days	450 Days	500 Days	600 Days	700 Days	Death	
Small dose	Control (15)	366 ±8.6	383 ±10.6	389 ±10.8	377 ±11.5	339 ±18	314 ±23	242 ±13.8	400 ±10.1
	Growth Hormone* (15)	381 ±10.6	398 ±12.7	406 ±11.1	398 ±12.7	366 ±16	323 ±17	260 ±17.3	416 ±11.2
	Difference	+15	+15	+17	+22	+27	+9	+18	+16
Large dose	Control (10)	387 ±6.0	413 ±5.4	421 ±7.2	424 ±8.1	400 ±17	359 ±23	247 ± 7.6	436 ±6.7
	Growth Hormone† (10)	380 ±9.2	405 ±11.4	444 ±10.7	431 ±22	437 ±36	344 ±23	283 ±10.4	490 ±19
	Difference	−7	−8	+23	+7	+37	−15	+36	+54

* Small dose: 0.2 mg. at 400 days, increasing by 0.2 mg. each 20 days to 2.0 mg. at 600 days.
† Large dose: 1.0 mg. at 400 days, increasing by 1.0 mg. each 14 days to 15.0 mg. at 600 days.

ment (at 450, 500, and 600 days) and after treatment at 700 days are compared with the corresponding weights in the control animals.

In the male rat of this Wistar strain body weight normally rises to a maximum at about 500 days and then declines progressively in old age (12, 13, 17). Animals used in the preliminary study, where the effects of small doses of growth hormone were investigated, attained their maximum weight at an earlier age (table 2) than those used in the large dosage experiment. For this reason controls in the small dosage experiment showed an earlier decline in body weight than those in the large dosage experiment.

Small doses of growth hormone had no significant effect on the body weight of the middle-aged rat.

Large doses of growth hormone produced a significant increase in body weight during the first 50 days of treatment compared with the controls ($t = 5.15$, $P<0.01$). During this period from 400 to 450 days of age, rats treated with growth hormone gained an average of 39 Gm. compared with 8 Gm. in the controls.

Further changes in the mean body weight of rats in the large dosage group were complicated by the uncontrollable loss of weight in two rats which died during the period of treatment (fig. 1). The effect of growth hormone on body weight may be seen more clearly in the group of rats which survived more than 700 days (fig. 2), where the effect of premortal weight loss is small. In these rats body weight increased progressively as the dose of growth hormone was increased. The maximum gain in weight in relation to the control weight occurred at 600 days and amounted to 72 Gm. (fig. 2). The maximum weight gain in relation to the weight at 400 days in individual rats varied from 36 to 210 Gm.

When treatment was discontinued at 600 days, body weight decreased rapidly, returning to the normal position on the body weight age curve after about 50 days (fig. 2).

The mean body weight at death (table 1) of rats which received large doses of growth hormone in middle age was 36 Gm. greater than that of the controls ($t = 2.66$, $P<0.05$). However, when the body weights of the two rats which died during treatment (306 and 330 Gm.) were discarded, the difference was no longer statistically significant. At death these two rats had lost 163 and 119 Gm. from the maximum weight compared with a mean loss of 189 Gm. in the control group. These observations suggest that growth hormone may reduce the senescent loss of weight.

The effect of large doses of growth hormone (12 mg. per day) on the senescent loss of weight was therefore studied in 10 old rats, which, before treatment, were losing weight at the rate of about 1 Gm. per day (fig. 3). These animals, whose mean senescent weight loss from the maximum weight was 129 Gm., had a mean age of 837 days (range 796 to 954) and a mean residual life of 32 days (range 3 to 65). Two rats, which died before the test was completed, failed to increase their body weight in response to growth hormone injections. However, the remaining 8 animals (residual life ranging from 12 to 65 days) showed a mean gain in body weight of 14 Gm. at the end of a 5-day-course of growth hormone injections (fig. 3). This

TABLE 2. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, AT 2 DOSAGE LEVELS, DURING THE PERIOD FROM 400 TO 600 DAYS OF AGE ON THE LIFE DURATION OF MALE RATS. THE ACTUAL LIFE DURATION IS COMPARED WITH THE LIFE DURATION PREDICTED FROM THE RELATIVE WEIGHT INCREMENT FROM 300 TO 400 DAYS, AND WITH THE MEAN AGE AT WHICH THE MAXIMUM WEIGHT OCCURRED.

Experiment	Group	Number of Rats	Relative Weight Increment	Predicted Life Duration (Days)	Actual Life Duration (Days)	Age at Maximum Weight (Days)
Small dose	Control	15	0.039 ±0.009	754	742 ±32	484 ±19
	Growth Hormone	15	0.041 ±0.012	757	751 ±33	470 ±13
Large dose	Control	10	0.050 ±0.008	776	782 ±43	502 ±16
	Growth Hormone	10	0.049 ±0.009	774	705 ±40	528 ±23

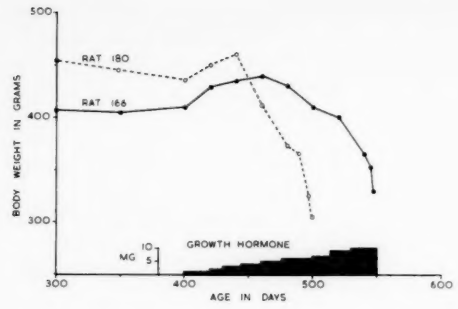

Fig. 1. The failure of pituitary growth hormone in large doses to prevent the loss of weight in 2 rats which died during treatment.

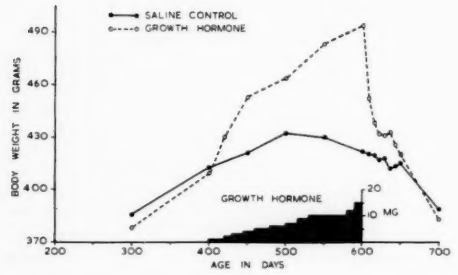

Fig. 2. The effect of daily intraperitoneal injections of pituitary growth hormone on body weight in rats which lived more than 700 days. Data were obtained from 5 growth-hormone-treated rats and 7 control rats which received daily injections of 0.9% NaCl.

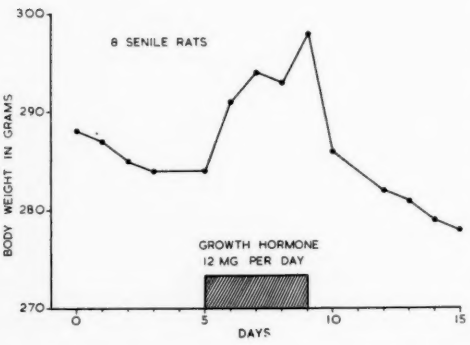

Fig. 3. The effect of pituitary growth hormone on the body weight of 8 senile rats of mean age 846 days, which before treatment were losing about 1 Gm. in weight per day.

gain of 14 Gm. is small when compared with the senescent weight loss of 129 Gm. Although treatment with large doses of growth hormone failed to prevent the premortal loss of weight (fig. 1), it was able to reduce this loss by 10 to 20%.

Duration of Growth.—In this study growth is assumed to cease at the age when the maximum weight is attained, and therefore the duration of growth is taken as the period from birth to the attainment of maximum weight.

Large doses of growth hormone had no statistically significant effect on the duration of growth. Growth hormone merely increased the magnitude of the maximum weight ($t = 2.52$, $P<0.05$; table 1), without significantly advancing the time at which it occurred (table 2). Data presented in figure 2 at first suggest that growth hormone may have prolonged the duration of growth in the group of rats surviving more than 700 days. However, when the data are examined more closely it is found that only 3 of the 5 rats responsible for the growth hormone curve continued to gain weight throughout the treatment period. The other 2 rats reached their maximum weight at about 460 and 525 days, respectively. Therefore, while figure 2 may suggest that growth hormone prolongs the duration of growth, this is not true statistically. The data of Moon and associates (28) also show that growth hormone does not prolong the duration of growth in the male rat to a significant extent.

Life Duration.—The life duration (L) of each group of rats was predicted from the relative weight increment between 300 and 400 days ($\triangle W$), using the equation $L = 669 + 2140\triangle W$ based on data published earlier (17). The predicted and actual life durations of these groups are compared in table 2. In the small dosage experiment there was good agreement between the predicted and actual life durations of both growth hormone and control groups, indicating that small doses of growth hormone did not affect the life duration.

In the large dosage experiment there was good agreement between predicted and actual life durations in the control group, but not in the growth hormone group, where the actual life duration was 69 days less than predicted. This observation suggested that large doses of growth hormone reduced the life duration, but this could not be confirmed statistically by the usual t test ($t_{18} = 1.30$, $P>0.05$), the matched

TABLE 3. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, AT 2 DOSAGE LEVELS, DURING MIDDLE AGE FROM 400 TO 600 DAYS OF AGE, ON THE LIFE DURATION IN DAYS OF INDIVIDUAL RATS.

Small Dose				Large Dose			
Controls		Growth Hormone		Controls		Growth Hormone	
506	789	485	771	574	748	499	747
600	816	633	795	637	889	547	748
634	834	644	824	682	894	610	763
650	846	670	839	731	924	656	842
663	872	683	857	744	993	737	900
670	902	692	918				
704	911	730	990				
741		731					

TABLE 4. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, IN LARGE DOSES TO MALE RATS FOR 200 DAYS DURING MIDDLE AGE, ON THE AGE CHANGES IN FOOD AND WATER CONSUMPTION AND IN FECES AND URINE PRODUCTION AND THE URINARY EXCRETION OF VARIOUS CONSTITUENTS.

Quantity	Units	Control			Growth Hormone			F Between Ages	F Between Treatments
		Youth	Middle Age	Old Age	Youth	Middle Age	Old Age		
Number of rats		10	10	8	10	10	5		
Age	Days ±S.E.	317 ±3.2	467 ±2.1	702 ±0.2	317 ±2.0	459 ±0.2	702 ±0.3		
Body weight	Gm. ±S.E	388 ±9.2	399 ±13.3	375 ±15.6	382 ±11.1	430 ±11.7	387 ±25		
Food consumption	Gm./Day ±S.E.	18.1 ±0.9	18.4 ±0.9	14.0 ±1.2	16.6 ±1.0	18.4 ±0.9	11.7 ±1.6	10.8 **	1.52
Feces production	Gm./Day ±S.E.	10.9 ±0.5	9.5 ±0.5	7.9 ±0.8	10.0 ±0.5	9.3 ±1.9	7.5 ±1.1	8.25 **	1.00
Water consumption	Ml./Day ±S.E	26.1 ±1.1	25.3 ±1.2	29.5 ±2.1	27.2 ±1.0	29.1 ±1.3	25.6 ±4.1	<1	<1
Urine production	Ml./Day ±S.E.	11.3 ±0.6	10.6 ±0.5	13.9 ±2.3	11.6 ±1.1	12.5 ±0.9	10.8 ±1.3	<1	<1
Protein excretion	Mg.N/Day ±S.E.	3.8 ±0.8	4.7 ±1.4	8.6 ±3.1	2.9 ±0.1	3.7 ±0.7	11.4 ±6.1	6.89 **	<1
Uric acid excretion	Mg./Day ±S.E.	3.9 ±0.31	3.9 ±0.15	4.6 ±0.25	4.0 ±0.20	4.0 ±0.19	4.4 ±0.32	3.07	<1
Creatinine excretion	Mg./Day ±S.E.	21.2 ±1.1	19.1 ±1.5	17.3 ±2.2	20.1 ±1.5	20.0 ±0.9	14.4 ±1.7	5.12 *	<1

* Significant at the 5% level
** Significant at the 1% level

pairs t test ($t_9 = 1.87$, $P>0.05$), nor by the analysis of covariance ($F_{1,17} = 3.12$, $P>0.05$).

Even in the group of rats which responded well to large doses of growth hormone (fig. 2) there was no statistically significant change in life duration.

The life durations of individual rats are given in table 3. There was no evidence of an increased mortality rate during treatment at either dosage level. There was, however, some evidence of an accelerated mortality rate in the post-treatment period in the large dosage experiment.

Consumption of Food and Water and Production of Feces and Urine.—In order to study the effect of growth hormone treatment on the natural age changes in body function, an analysis of variance was carried out on each set of

TABLE 5. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, IN LARGE DOSES TO MALE RATS FOR 200 DAYS DURING MIDDLE AGE ON AGE CHANGES IN THE BLOOD PICTURE.

Quantity	Units	Control			Growth Hormone			F Between Ages	F Between Treatments
		Youth	Middle Age	Old Age	Youth	Middle Age	Old Age		
Number of rats		10	10	8	10	10	5		
Age	Days ±S.E.	335 ±2.5	485 ±1.5	723 ±0.2	334 ±1.6	481 ±0.2	720 ±0.3		
Body weight	Gm. ±S.E.	398 ±7	419 ±8	385 ±15	392 ±10	439 ±16	388 ±21		
Hemoglobin (Oxyhemoglobin)	Gm./100 Ml. ±S.E.	16.4 ±0.39	16.7 ±0.32	17.6 ±0.35	17.0 ±0.28	16.5 ±0.26	18.6 ±0.71	7.10 **	1.27
Red cell count	10^6cells/cu.mm. ±S.E.	8.6 ±0.18	8.4 ±0.20	8.9 ±0.12	8.7 ±0.17	8.0 ±0.16	8.7 ±0.43	3.41 *	1.82
White cell count	10^3cells/cu.mm. ±S.E.	13.0 ±1.14	15.0 ±1.02	13.7 ±1.07	15.2 ±1.20	15.4 ±2.01	13.3 ±2.61	<1	<1
Eosinophil count	cells/cu.mm. ±S.E.	511 ±101	438 ±141	277 ±56	656 ±82	352 ±59	213 ±64	5.71 **	<1

* Significant at the 5% level
** Significant at the 1% level

data. In table 4, values for the variance ratio (F) between ages show that food consumption and feces production decreased with age, but no significant age change occurred in either water consumption or urine production.

The F-between-treatment values were not significant in any case, indicating that the administration of growth hormone had no significant effect on the age changes in these 4 variables. However, the analysis of covariance, which corrects for pre-treatment differences, showed that water consumption was increased significantly during the period of growth hormone treatment in middle age ($F_{1, 17} = 4.53$, $P<0.05$).

There was no evidence that growth hormone affected the course of aging in any of these variables in the post-treatment period in old age.

Excretion of Urinary Constituents. — From table 4 it may be seen that the excretion of creatinine decreased significantly with age, while the excretion of protein increased significantly. The F-between-treatment values were not statistically significant, thereby showing that these age changes were not affected by treatment with growth hormone in middle age.

Blood Picture.—Data in table 5 show that significant age changes occurred in the hemoglobin level, red cell count, and eosinophil count in the male rat. The F-between-treatment values show that these age changes were not significantly affected by treatment with growth hormone. The white cell count was not affected by either age or treatment with growth hormone.

Blood Sugar and Blood Cholesterol.—Determinations of the fasting levels of blood sugar and total blood cholesterol were made during the last week of treatment, when rats were receiving 13 mg. of growth hormone per day (table 6).

The blood sugar level was significantly higher in growth-hormone-treated rats than in the control rats of the same age ($t = 2.58$, $P<0.05$). In rats receiving growth hormone injections the two highest blood sugar levels were 345 and 258 mg. % compared with 85 and 73 mg. % in the controls. The diabetogenic action of growth hormone has been demonstrated previously in the adult cat (8) and dog (6) but not in the rat (10, 11).

There was no significant alteration of the total blood cholesterol level during treatment with growth hormone.

Systolic Blood Pressure and the Electrocardiogram.—There was no significant change in systolic blood pressure in the caudal artery of

TABLE 6. THE EFFECT OF PROLONGED TREATMENT WITH PITUITARY GROWTH HORMONE ON THE SYSTOLIC BLOOD PRESSURE, BLOOD SUGAR LEVEL, AND BLOOD CHOLESTEROL LEVEL IN MALE RATS.
Injections were made once daily, commencing in middle age at 400 days

	Controls			Growth Hormone		
	N	Age (Days)		N	Age (Days)	
Systolic blood pressure (10 mg. growth hormone daily)	8	573± 0.2	119± 4.7*	6	573± 0.2	120± 11.3*
Fasting blood sugar (13 mg. growth hormone daily)	6	592± 0.2	61± 6.8†	6	592± 0.2	173± 43.0†
Fasting blood cholesterol (13 mg. growth hormone daily)	6	592± 0.2	95± 4.5†	6	592± 0.2	102± 3.1†

* Mm. Hg.
† Mg. %

TABLE 7. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, IN LARGE DOSES TO MALE RATS FOR 200 DAYS DURING MIDDLE AGE ON AGE CHANGES IN HEART RATE AND THE QRS VECTOR IN THE FRONTAL PLANE.

Quantity	Units	Control			Growth Hormone			F Between Ages	F Between Treatments
		Youth	Middle Age	Old Age	Youth	Middle Age	Old Age		
Number of rats		10	10	8	10	10	5		
Age	Days ±S.E.	306 ±1.2	552 ±2.1	731 ±0.2	307 ±0.8	530 ±1.5	727 ±0.3		
Body weight	Gm. ±S.E.	390 ±7	418 ±10	378 ±19	385 ±11	450 ±21	376 ±22		
Heart rate	Beats/min. ±S.E.	394 ±5.5	372 ±8.9	363 ±16.8	388 ±12.5	363 ±10.1	359 ±12.2	3.51 *	<1
QRS vector magnitude	/μV ±S.E.	296 ±22	243 ±13	294 ±13	264 ±14	217 ±17	228 ±14	<1	<1
QRS vector direction	Degrees ±S.E.	57 ±5	53 ±9	16 ±11	50 ±4	38 ±9	50 ±23	<1	<1

* Significant at the 5% level

TABLE 8. THE EFFECT OF DAILY ADMINISTRATION OF PITUITARY GROWTH HORMONE, IN LARGE DOSES TO MALE RATS FOR 200 DAYS DURING MIDDLE AGE ON THE WEIGHTS OF VARIOUS ORGANS AT AUTOPSY.

Group	Number of Rats	Weight ± S.E. of						
		Body (Gm.)	Lungs Combined (Gm.)	Heart Ventricles (Gm.)	Liver (Gm.)	Kidneys Combined (Gm.)	Testes Combined (Gm.)	Adrenals Combined (mg.)
Control	10	247 ±7.6	7.5 ±1.43	1.04 ±0.05	10.0 ±0.78	2.81 ±0.19	1.26 ±0.25	99 ±21
Growth hormone	10	283 ±10.4	8.2 ±1.18	1.10 ±0.07	9.6 ±0.71	2.71 ±0.03	1.72 ±0.12	77 ±6.5
t		2.66 *	0.40	0.76	0.34	0.50	1.65	0.99

* Significant at the 5% level

middle-aged rats receiving 10 mg. of growth hormone per day (table 6). This observation agrees with that of Moon and associates (28) in a similar study on middle-aged rats treated with growth hormone.

Data given in table 7 show that heart rate decreased significantly with age, but no significant age change occurred in either the magnitude or direction of the QRS vector in the frontal plane. The treatment of middle-aged rats with growth hormone did not produce any significant changes in either heart rate or the QRS vector.

Pathological Changes. — The postmortem weights of the lungs, heart ventricles, liver, kidneys, testes, and adrenals, in the 10 rats which received large doses of growth hormone during middle age, were not significantly different from those in the 10 control rats (table 8). Ventricular hypertrophy as indicated by ventricular weight exceeding 1.30 Gm., was present in two growth-hormone-treated rats (1.38 and 1.51 Gm.) and in one control (1.31 Gm.).

The severity of lung disease at autopsy was graded according to the area of the external lung surface covered with lesions (mild 1-25% of lung covered with lesions, moderate 26-50%, severe more than 50%). Of the 10 rats treated with growth hormone 8 had lung disease at autopsy (3 mild, 4 moderate, 1 severe). In the control group there were also 8 rats with lung disease (6 mild, 2 moderate). Thus moderate and severe lung disease were more prevalent in growth-hormone-treated rats with 5 cases than in the controls with only 2 cases.

Two tumors were observed in gross examination of the control group (adrenal 220 mg., and skin tumor 23.5 Gm.), and two in the growth-hormone-treated group (skin tumor 5 Gm., and mammary tumor 140 Gm.). No body function data obtained in old age from the rat bearing the large mammary tumor have been included in tables of results. These data on tumor frequency are largely in agreement with those of Moon and associates, who showed that the long term administration of growth hormone increased the incidence of tumors in female rats (29), but had no general effect on tumor incidence in male rats (28), apart from increasing the incidence of pheochromocytomas of the adrenals.

Severe nephrosis, as indicated by the excretion of more than 20 mg. of protein N per day in old age, was present in two growth-hormone-treated rats (35.5 and 55 mg. N) and in one control rat (28.6 mg. N).

From the blood sugar estimations, two rats in the group treated with large doses of growth hormone were found to have diabetes mellitus (fasting blood sugar levels 258 and 345 mg. %) during treatment.

DISCUSSION

Before the effects of growth hormone on the aging process in the rat could be assessed, it was first necessary that a number of indices of growth and aging be developed in the rat.

Indices of Growth and Aging in the Rat.—In this study the only index of growth used was the change in body weight with age. While this index may be satisfactory in rats gaining weight during treatment with pituitary growth hormone, it is less reliable in middle-aged control rats where an increase in body weight could be due to an increase in body fat rather than an increase in the weight of the skeleton and muscle tissue. A better index of growth may, for example, have been either that of skeletal growth as measured by changes in body length, or perhaps that of the changes in the lean body mass as followed by serial estimates of creatinine excretion.

Various tests of body function (tables 4, 5, and 7) were used in this study for tracing the effect of growth hormone on the course of aging in the rat. Although a number of these variables (food consumption, urinary protein and creatinine excretion, blood hemoglobin level, eosinophil count, heart rate, and the direction of the mean electric axis) show moderate changes with age, they are not necessarily true indices of physiological aging in the rat. It is likely that some of these indices are really measures of pathological aging, as, for example, the rise in protein excretion with age which is probably related to the development of nephrosis (15).

Growth Hormone and Aging.—The fact that senescence follows the cessation of growth in mammals suggests that senescence is either due to the failure of growth (23, 24) or is merely the next stage in the life cycle program (7). If senescence is simply due to the failure of growth, then the stimulation and maintenance of growth in the aging rat should postpone senescence. For this purpose pituitary growth hormone was selected, first because of its strong growth-promoting action in the rat, and second

because some of its anabolic properties have been demonstrated in the old rat (2, 28, 39).

In this study growth hormone in large doses (up to 15 mg. per day) was able to increase body weight in middle age when growth normally ceases (fig. 2), and to reduce the senescent loss of weight in old age (fig. 3). Growth hormone, however, failed to prevent the final decline in body weight as the animals approached death (fig. 1), the reduction in senescent weight loss being only 10 to 20%. In middle age, after the age of 500 days, more and more rats passed into the phase of senescent weight loss and therefore lost weight, even though large doses of growth hormone were being administered. Therefore, continuous growth could not be maintained in these rats, and as a result the mean duration of growth of the whole group was not prolonged significantly (table 2).

These body weight studies thus showed that neither the cessation of growth nor the subsequent loss of weight in the male rat are due primarily to a deficiency of growth hormone. These investigations, therefore, indicate that senescence in the male rat is not due to a deficiency of pituitary growth hormone.

Body function studies (tables 4, 5, and 7) showed that the prolonged administration of large doses of growth hormone in the middle-aged rat had very little effect on the subsequent course of aging.

It may therefore be concluded that the pituitary growth hormone is not an important factor in the aging of the middle-aged and old male rat.

SUMMARY

The intraperitoneal administration of small daily doses of pituitary growth hormone (an average of 1 mg. per day) over a period of 200 days in middle age, had no significant effect on either body weight or life duration in the male rat.

When moderately large doses of growth hormone (an average of 5 mg. per day) were administered for 200 days in middle age, significant increases were observed in body weight, water consumption, and the fasting blood sugar level. Apart from these changes, prolonged treatment with large doses of growth hormone did not affect the course of physiological aging in 6 metabolic, 4 hematological, and 3 electrocardiographical variables. The reduction of 70 days in mean life duration was not statistically significant.

Large doses of growth hormone failed to prevent the final decline in body weight as rats approached death, since the senescent loss of weight was reduced by only 10 to 20%.

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THE HISTOCHEMICAL NATURE AND POSSIBLE SIGNIFICANCE OF THE SUBPERIOSTEAL REVERSAL LINES OF AGING RAT FEMORA

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Reversal lines are histological imprints seen in bone as a consequence of intermittent appositional growth. Cyclic changes in bone structure resulting in the formation of reversal lines have been demonstrated in 1932 by Jaffe, Bodansky and Blair (10) after injecting rabbits with parathormone. Storey (16) also described the presence of these lines which demonstrated the new layers of bone produced by repeated waves of resorption and deposition, as a consequence of the intermittent treatment of rabbits with cortisone. Reversal lines were encountered subperiosteally around vascular spaces in cortical bone and the medullary trabeculae (17). These lines were readily seen by staining darkly with hematoxylin.

Opaque striae have been seen in roentgenograms of the long bones of patients who have had a succession of alternate cures from and relapses of rickets (7, 8). Harris noted that these striae actually developed as a consequence of a great variety of infectious diseases during the period of childhood. The striae were named lines of arrested growth, since they represented landmarks of transitory arrest of bone growth. Numerous investigators have shown lines which are essentially similar to those described above, having been produced by metal poisoning. Caffey (3) reveals narrow, sharp striae in the long bones of children poisoned by bismuth. Boerema (2), Gottesleben (4), and Siegling (14) found radio-opaque striae after phosphorus intoxication. Lead poisoning also produced comparable findings (18).

It seems then that a variety of agents are capable of arresting bone growth and that such arrests are demonstrated by the so-called reversal lines or lines of arrested growth. Lines similar to those described by Storey and others have been noted even in normal rats at various ages in our laboratory. It has been known for some time that periosteal activity is intermittent during normal (19) or neoplastic growth (15). Whether the lines seen in normal rats have been produced by hormonal influence on periosteal activity, as was revealed by Storey after cortisone treatment, is not known; however, the nature of these reversal lines in normal animals becomes a matter of basic information. Since the chemical nature of these lines has not been investigated previously, it was believed profitable for a more complete understanding of the biochemistry and dynamics of skeletal growth to describe our histochemical observations.

MATERIAL AND METHODS

Observations were made from undecalcified sections of femoral bone taken from 36 Sprague-Dawley rats, comprising 6 age groups of 6 animals each. The ages of the animals ranged from 0 to over 104 weeks; and the animals were examined at the ages of 1, 5, 8, 26, 52, and 104 weeks. The following histochemical studies were employed:

1. Toluidine blue O method for metachromasia (6),
2. Rinehart and Abu'l-Haj colloidal iron method for acid mucopolysaccharides (13),
3. Periodic acid Schiff method of Hotchkiss (9) for neutral mucopolysaccharides, and
4. Hyaluronidase treatment prior to the application of the histochemical procedures.

Femoral measurements were made on specimens from the animals used in these experiments and on a group of 100 femora from animals of various ages previously collected in our laboratory. About 25 femora were available for study in each age group. The length of each femur was measured by means of a pair of calipers from the greater trochanter to the lateral and medial condyles. Measurements of the width were made at the mid-diaphyseal region under a stereomicroscope fitted with an ocular micrometer. Each femur was then cross-sectioned at the mid-diaphyseal region and measurements were made of the thickness of the compact bone at the thinnest portions.

Submitted for publication March 5, 1959.

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In the toluidine blue method, the use of freshly prepared mixture of equal parts of 5% ammonium molybdate and 1% potassium ferrocyanide and acetone, instead of alcohol, in the brief dehydration of the tissue sections adequately prevented the loss of metachromasia.

The Schiff reagent was prepared by the method of Barger and DeLamater (1). In order to increase the specificity of the reaction, additional slides from all groups were treated with a mixture of 10% acetic anhydride in dry pyridine for one hour at room temperature to induce acetylation of the 1:2 glycol groups responsible for the PAS reaction (12). Another set of slides, after treatment with anhydride-pyridine mixture, were treated with 0.1 M KOH for one hour to reverse the process of acetylation and thus stained with PAS (11). Diastase control sections incubated at 37 C. for two to three hours were also used to eliminate glycogen staining. One-half of the sections of all groups were treated prior to toluidine blue O, colloidal iron and periodic-Schiff staining with a 0.1% testicular hyaluronidase (Wydase, 150 TRU/mg)* in physiological saline for 4 hours at 37 C. (5). Control sections incubated with saline alone were also made.

The uptake of S^{35} at the regions of the reversal lines is reported from autoradiographic observations made during collaborative work at Brookhaven National Laboratory. The animals received 400 μc. of $H_2S^{35}O_4$ / 100 Gm. body weight in two subcutaneous injections 12 hours apart. The animals were sacrificed by etherization 5 hours after the last injection.

RESULTS

Narrow lines, running parallel with the diaphyseal cortex of normal rat femora, have been noted in all animals at 52 weeks of age and older (fig. 1). These characteristic lines were not observed in animals 26 weeks of age and younger. Five parallel lines were seen throughout the depth of the femoral cortex by their outstanding staining properties. Since reversal lines were noted in animals 52 weeks of age, the formation of these lines, or the intermittent periods of arrested growth, seem to last for approximately 5 weeks. No differences between males and females were observed either in the number of lines, their distance from one another, or their staining characteristics. Similar lines were noted in the trabeculae of the epiphysis as well as the femoral diaphysis (fig. 2).

Numerous cracks, occurring at the reversal lines and parallel with them, were seen in these sections (figs. 3 and 4).

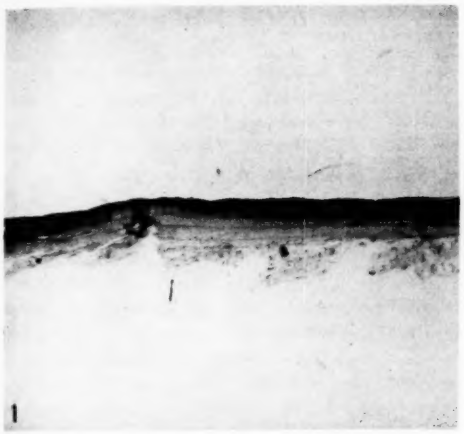
Histochemical studies of undecalcified sections revealed an orthochromatic staining of the reversal lines after treatment with toluidine blue. The adjacent bone and fibrous matrix of the periosteum exhibited β-metchromasia while the preosseous zone was γ-metachromatic. Only the preosseous zone gave a β-metachromasia after hyaluronidase treatment. The other components remained unaffected. Reversal lines stained blue with the colloidal iron method, whereas the cortical bone connective tissue of the periosteum, and the preosseous zone, were intensely red. The blue staining of the reversal lines was not removed after treatment of the sections with hyaluronidase. Periodic acid-Schiff staining was limited to fibrous elements throughout the periosteum and bone cortex. Reversal lines were also periodic acid-Schiff positive; however, they could not be clearly outlined since the areas about them were also similarly stained. Schiff staining was not altered following hyaluronidase treatment.

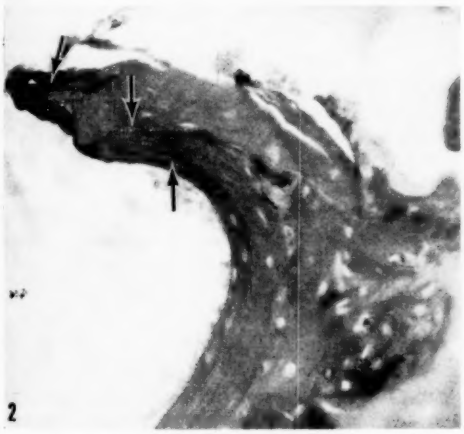
Examination of autoradiographs revealed a major uptake of S^{35} at the active osteoblastic layer of the periosteum and preosseous zone. Although less uptake was seen in the cortical bone, no preferential uptake of S^{35} occurred at the reversal lines, and consequently the lines could not be seen in the autoradiographs. The treatment of tissue sections with hyaluronidase prior to the preparation of the autoradiographs resulted in a loss of radioactivity of the tissue sections in areas such as the periosteum, preosseous zone, and bone cortex.

A comparison of the histochemical findings at various sites is given in table 1.

Analysis of the femoral size measurements obtained (table 2), indicates that the average length, width, and thickness of bone in the normal rat increases immediately after birth to about 26 weeks of age. The following ages show only a slow but progressive increase in the average length and width. The average thickness of the compact bone, however, decreases somewhat beyond 26 weeks of age (fig. 5). The data in table 2 were analyzed statistically by probability values derived from Fisher's t, having a critical ratio of 2.485 ($P<0.01$). This ratio applies to age-group comparisons within each type of measurement.

* Wydase is the trade name for a lyophilized testicular hyaluronidase prepared by Wyeth Inc., Philadelphia.





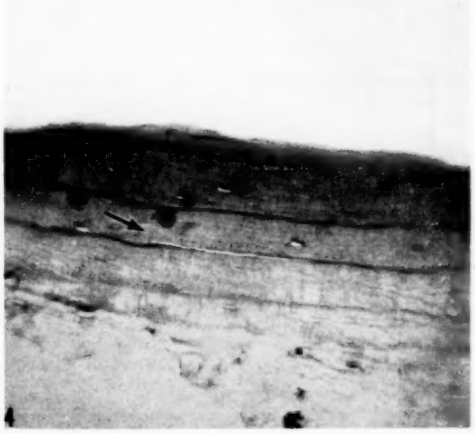


Fig. 1. A longitudinal section of the cortex of the femoral diaphysis exhibiting subperiosteal reversal lines. Toluidine blue O staining. X 100.

Fig. 2. A trabeculum of bone showing reversal lines (indicated by the arrow). Colloidal iron staining. X 430.

Fig. 3. The photomicrograph reveals deeply staining subperiosteal reversal lines in the diaphyseal cortex of the femur. Cracks occurring preferentially at the reversal lines are indicated by the arrow. Toluidine blue O staining. X 430.

Fig. 4. A photomicrograph similar to fig. 4, exhibiting a long fracture along the reversal line (indicated by an arrow). Toluidine blue O staining. X 430.

DISCUSSION

In considering a review of the literature, the lines described in this paper, which were noted in normal rats, seem to be essentially similar to the lines formed as a result of hormonal treatment (10, 16, 17), metal poisoning, and a variety of infectious diseases (7, 8) inasmuch as these striae represent intermittent periods of arrested bone growth followed by recurrences of bone growth. Similarity does not exist, however, in origin between the striae produced by metal poisoning and infectious diseases on one hand and hormone treatment on the other, since the former occur as a result of metaphyseal changes, while the latter take place as a result of an effect upon cortical appositional growth. The lines observed in normal rats fit into the category of hormonally-induced cortical striae formation. The finding of reversal lines in subperiosteal cortex of normal rat femoral diaphysis is in agreement with the observations by Weinmann and Sicher (19), that the periosteum during the normal growth of the skeleton reveals intermittent periods of activity.

TABLE 1. A COMPARISON BETWEEN HISTOCHEMICAL REACTIONS OF THE REVERSAL LINES OF THE FEMORAL CORTEX OF THE RAT DIAPHYSIS.

	Toluidine Blue O		Colloidal Iron		Periodic Acid-Schiff		Sulfur^{35} Uptake	
	No H	H	No H	H	No H	H	No H	H
Reversal lines	Ortho (blue)	Ortho (blue)	Blue	Blue	Positive	Positive	Low	Low
Adjacent cortical bone	β (purple)	β (purple)	Red	Red	Positive	Positive	Low	Low
Connective tissue	β (purple)	β (purple)	Red	Red	Positive	Positive	Low	Low
Preosseous zone	γ (red)	β (purple)	Red	Red	Positive	Positive	High	Low

No H = No hyaluronidase treatment.
H = Hyaluronidase treatment prior to staining or preparation of autoradiographs.

TABLE 2. THE MEAN ± SE OF VARIOUS MEASUREMENTS TAKEN FROM THE FEMORA* OF RATS AT VARIOUS AGES.

Age (Weeks)	1	5	8	26	52	104
Length (cm.)	1.7 ± 0.05	2.4 ± 0.07	3.0 ± 0.06	3.6 ± 0.07	4.1 ± 0.09	4.7 ± 0.06
Width (mm.)	2.5 ± 0.04	3.0 ± 0.04	3.5 ± 0.05	3.8 ± 0.05	4.5 ± 0.10	4.8 ± 0.09
Femoral Cortical Thickness (Mid-Diaphyseal in mm.)	0.20 ± 0.01	0.48 ± 0.05	0.57 ± 0.01	0.73 ± 0.03	0.68 ± 0.02	0.68 ± 0.02

* Each group was made up of approximately 25 femora.

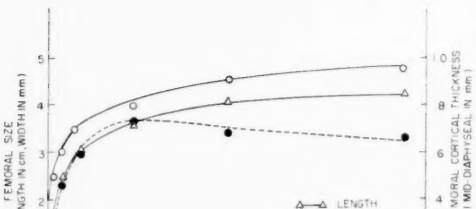


Fig. 5. The composite graph represents a comparison between the average length, width, and thickness of rat femora from birth to old age. The length is measured from the greater trochanter to the lateral and medial condyles. Width and thickness of the compact bone were measured at the mid-diaphyseal region.

Since lines were found in animals beyond 52 weeks of age, it seems that, at least in the rat, the intermittent periods of periosteal appositional bone growth occur chiefly after 26 weeks of age. The presence of 5 lines at 104 weeks as well as 52 weeks of age is an indication that the apposition and absorption of bone occurs at much the same rate, so that the addition of a new line is accompanied by the absorption of another. The periods seems to occur approximately 5 weeks apart. Caliper measurements made of femoral bone indicate that although the average length and width continue to increase progressively, the cortical bone becomes somewhat thinner. The thinning is first observed in the 26-week-old rats. This probably indicates that the processes of absorption are more effective than the processes of appositional growth, resulting in the widening of the medullary canal and thinning of the compact bone.

From histochemical findings, reversal lines seem to represent an area devoid of calcium or containing much lower calcium than the adja-

cent surrounding bone. If this were not the case, colloidal iron staining would have produced a red color masking the blue staining obtained. Similarly if the calcium content is lower, the lines should be more susceptible to a stressing force and therefore more likely to come apart. As a result of microtome sectioning of undecalcified bone, numerous breaks have been found preferentially oriented along the length of the reversal lines.

Reversal lines failed to produce γ-metachromasia after toluidine blue staining and also failed to take up more S^{35} than the surrounding bone. The Schiff-positive reaction and blue staining following the colloidal iron reaction were not affected by hyaluronidase treatment. The preosseous zone on the other hand was γ-metachromatic, and became β-metachromatic after hyaluronidase treatment. Hyaluronidase treatment also removed the S^{35} activity of the preosseous zone and the blue staining produced after colloidal iron treatment. These reactions indicate that a sulfated, acid mucopolysaccharide, probably chondroitin sulfate, is present at the preosseous zone, whereas the reversal lines exhibit the presence of a non-sulfated, non-acidic mucopolysaccharide.

On the evidence at hand, the finding of reversal lines in normal rats indicates that, in support of Weinmann and Sicher (19), periosteal appositional bone growth does reveal periods of intermittent activity, and that the chemical nature of these lines is essentially a non-sulfated, non-acidic mucopolysaccharide. It is not known whether this intermittent activity is under the influence of hormones or some other mechanism, yet, it creates a difference between the rates of deposition of new bone and absorption of pre-existing bone, accounting for the widening of the medullary canal with increasing age.

SUMMARY

Reversal lines have been observed, particularly in the femoral cortex of the diaphysis of 36 normal Sprague-Dawley rats beyond 26 weeks of age. The presence of these lines indicates that periosteal appositional bone growth is intermittent. The periods seem to occur approximately 5 weeks apart. Intermittent periosteal activity accounts for the widening of the medullary canal with increasing age. The histochemical reactions of the reversal lines have been found compatible with a non-sulfated, non-acidic mucopolysaccaride.

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RATE AND MAGNITUDE OF AGE PIGMENT ACCUMULATION IN THE HUMAN MYOCARDIUM

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Among the relatively unexplored possible mechanisms of aging (22) is the following: the processes of metabolism produce, directly or by accident, a series of insoluble and non-functional side-products which accumulate and figuratively clog up the chemical machinery of the cells. For a half century, it has been known that certain tissues of aged humans and other animal species contain golden brown pigment inclusions currently termed lipofuscins or age pigments.* Although limited information is available regarding their physical (7, 16, 17) and histochemical properties (7, 17, 20), the origin and function, if any, of these pigments remain purely speculative.

In 1911 Stübel and others (27), using ultraviolet light, observed a dark brown fluorescence of animal hearts. Bommer (3), employing ultraviolet microscopy, noted yellow fluorescent granules within human myocardial fibers. Hamperl (14) confirmed and extended Bommer's observations, pointing out that the fluorescent particles, similar to lipofuscin age pigment particles, were absent in the hearts of subjects below age 10 and were located at the poles of myocardial nuclei when present. Further, Hamperl correlated the apparent color of lipofuscins with the intensity and color of the fluorescent particles, leaving little doubt of their identity. In his opinion, fluorescence microscopy was the most sensitive technique for demonstrating age pigment. The possibility that this is a relatively short-lived phosphorescence rather than a fluorescence has not been explored.

Other physical properties attributed to lipofuscins include an insolubility in various solvents (5, 7, 17), an electron microscopic similarity to the Golgi apparatus in rat neurons (4) and a relatively high X-ray mass in human neurons (16). Hyden and Lindstrom (16), using microspectrography, have reported absorption peaks at 2600 Å and 3750 Å and fluorescence emission bands between 4400-4600 Å and 5300-5600 Å for human neuronal lipofuscin.

Numerous histochemical studies have been performed on lipofuscin and are summarized elsewhere (7, 17, 20). Using acid-fast staining in human autopsy specimens, Jayne (17) observed qualitatively a progressive agewise increase in myocardial pigment between the second and sixth decades.

From this mass of information very little can be deduced with assurance regarding the chemical structure of age pigments or their relationship to the normal or abnormal metabolism of the tissues in which they are found. The present study was undertaken in order to assess the possibility that these substances are, in fact, associated with aging.

In the present report are described the results of a quantitative study of the agewise occurrence of this pigment in the human myocardium. The findings agree with previous reports (14, 17) that myocardial lipofuscin is absent in the very young and is universally present in older subjects. More important, it is shown that the substance accumulates linearly (in a population) with age at the average rate of approximately $\frac{1}{3}\%$ of the total heart volume/decade. The pigment accumulation does not seem to be significantly altered by overt heart disease or heart failure or to be dependent upon the sex or race of the source material.

Submitted for publication April 6, 1959.

The authors gratefully acknowledge the capable assistance of Miss Ann Nesteruk in the preparation of the tissue and of Miss M. Susanne Herman in the calculations. We also wish to thank Dr. Nathan Shock for his useful suggestions and criticisms of this work and Dr. Melvin Davidoff and Mr. Arthur Norris for their advice and aid on the statistical calculations.

* The term "lipofuscin" was orginated by Borst (see reference 15) for the intracelluiar brown pigment particles, weakly stained by fat stains, presumably derived from lipids. These particles have been described in myocardial fibers, ganglion cells, smooth muscle, connective tissue cells, and in genital epithelium (14). They are increased in old age, brown atrophy, and, according to some, in hemochromatosis (7, 8), cachexia (8), and Bantu siderosis (8).

Other terms transiently used for lipofuscin were "fetthaltiges Abnutzungspigment" (22), "melanin" (25), "hemofuscin" (7, 18, 23), and "hemofuchsin" (17). The pigment was erroneously called melanin because of the absence of iron and the presence of 3.25-3.70% sulfur in its elementary analysis (5, 21). The prefix "hemo" existed because of the unproved belief that the pigment was a precursor of hemosiderin. According to Sheldon (23), the evidence for this viewpoint was based on improper staining methods for iron. The stem "fuchsin" (a cationic dye) probably resulted from confusion with fuscin (Latin for brown), the former often being used to stain lipofuscin (8).

MATERIALS AND METHODS

The autopsy tissues from 156 cases provided the material, which consisted of paraffin blocks of left ventricular heart muscle on file in the Pathology Department of Baltimore City Hospitals. Autopsied cases were chosen at random noting the age, race, sex, heart weight, the gross and microscopic cardiac abnormalities and the presence or absence of anatomic evidence of heart failure (for example, cardiac chamber dilatation; pulmonary or hepatic congestion; edema). When such evidence was present, the clinical records were examined in order to estimate the duration of heart failure. The age distribution of the cases is shown in figure 1.

The tissue was prepared by fixation in 20% formalin for two days followed by a 12-hour wash in tap water. It was stored in 80% alcohol prior to dehydration. Dehydration was carried out in 95% ethanol for a total of 18 hours and in 100% ethanol for a total of three hours. The samples were then transferred to 50% xylol/50% alcohol for one hour, cleared in 100% xylol for one hour and infiltrated in paraffin for two hours. The tissue was then imbedded in 100% paraffin (m.p. 52-56 C.). Five μ sections were made on a Model 820 Spencer Rotary Microtome. The paraffin was dissolved in xylene for 10 min. Two drops of a non-fluorescent solution containing 18 Gm. of isobutyl methacrylate in 100 cc. of xylene were used to mount the coverslip.

The unstained sections were viewed under non-fluorescent oil in a fluorescence microscope. The light source was a GE Projector Spot CH-4 collimated and focused on the microscope mirror by a conical reflector. Optics consisted of a Bausch and Lomb cardioid quartz condenser (1.00 mm. glass 1.05 mm.), a Bausch and Lomb 47.5 $\times$, 4 mm., .95 N.A. objective, a Bausch and Lomb 10 $\times$ compensated ocular fitted with a Kodak Wratten gelatin film (#4) and an American Optical Company 5 mm. net reticule ruled to $\frac{1}{2}$ mm. squares. Thus, a grid with 100 intersections was superimposed on the microscopic field. With the #4 Wratten filter, the yellow-green pigment fluorescence appeared bright orange and the broad blue-green fluorescence of the myocardial fibers appeared as pale yellow-orange.

The number of grid intersections overlying fluorescent pigment in focus was counted in 10 randomly selected fields and averaged. The result was expressed as the percentage of the section area occupied by pigment. Because of the shallow focal depth, this figure is equal to the volume percentage of pigment.* Chalkley (6) has developed a method similar to ours in principle which he has applied to ordinary rather than to fluorescence microscopy. The counts obtained were independent of section thickness over the range 4 to 10 μ (table 1). Five μ sections were used. This thickness was more convenient because it possessed fewer out-of-focus fluorescent areas and could be prepared more easily than thinner sections.

TABLE 1. PERCENTAGE LIPOFUSCIN BY VOLUME AS A FUNCTION OF SECTION THICKNESS OF A SINGLE HEART.

Section Thickness (Micra)	% Pigment by Volume*	Standard Deviation	Standard Error of the Mean
4	1.75	.42	.21
5	1.43	.19	.10
6	1.90	.19	.10
8	1.50	.43	.21
10	1.50	.32	.16

* Each value represents the average of 4 determinations on 4 slides.

RESULTS

Reliability of Method. Moderate variation in repeated readings of the same section was noted. For example, the standard deviations of 10 determinations on three slides, expressed as a fraction of their respective means, were .19, .21, and .35. Thus, the mean $\pm$ 20 to 35% would include two-thirds of all readings on a single slide. The variation among 5 slides, however, whose pigment concentration ranged from 1.1 to 1.8%, was found by variance analysis (11) to be significantly greater ($p < .001$) than the variation between repeated readings on any one of them (table 2).

Pigment Distribution. The assumption that pigment was homogeneously distributed throughout the entire heart (except at the subcellular level) was tested by assaying sections from several regions of the same heart (table 3). Although pairs of sections from different regions of three hearts showed no significant differences in pigment concentration, one of three sections from a fourth heart did show a significant dif-

* Principle of method: If one throws darts randomly toward a wall on which is hung a picture, the ratio of hits on the wall and picture gives the relative area of the picture and uncovered wall. By analogy—for very thin slices of any randomly heterogeneous material, the percentage volume occupied by any component may be estimated by measuring its percentage area; that is, the percentage of times that a randomly chosen point overlies the component in question. Since some of the granules have dimensions smaller than the depth of focus, our measurements will be slightly on the high side.

TABLE 2. ANALYSIS OF VARIATION OF CASES AND OF MEASUREMENTS.

	Determination	Case Number				
		15065	15129	15365	15162	16766
Pigment concentration (% by volume)	1	0.8	1.5	1.1	1.7	1.1
	2	1.1	1.4	1.4	1.2	1.2
	3	1.0	2.0	1.2	1.8	0.9
	4	1.5	2.1	0.8	1 9	1.2
	5	1.1	2.0	1.1	1.9	1.1
Average		1.1	1.8	1.1	1.7	1.1

Degrees of freedom 4 and 20
$F = 10.4$ $p < .001$

The difference between the percentage pigment of 5 cases is significantly greater ($p < .001$) than the variation among 5 determinations on any 1 of them.

TABLE 3. LIPOFUSCIN CONCENTRATION OF DIFFERENT VENTRICULAR REGIONS OF THE SAME HEART.

Case No.	Region	% Pigment by Volume*	Standard Deviation	Standard Error of the Mean
15065	Left Ventricle posterior	1.10	.23	.10
	Left Ventricle posterior	2.32	.39	.18
	Right Ventricle anterior	1.58	.39	.18
15129	Right Ventricle lateral	1,80	.29	.13
	Left Ventricle apex	1.76	.70	.32
15162	Left Ventricle posterior	1.70	.26	.12
	Left Ventricle apex	1.40	.24	.11
15365	Left Ventricle apex	1.38	.75	.34
	Left Ventricle posterior	1.12	.20	.09

* Average of 5 determinations.
Except for case no. 15065, slide II, the mean $\pm 2\sigma$ mn. overlap. With this exception, no significant differences are demonstrated.

TABLE 4. RELATION OF DEATH-AUTOPSY INTERVAL TO LIPOFUSCIN CONCENTRATION.

Death to Autopsy Interval (Hours)	No. of Cases	Average Pigment Ratio	Standard Deviation	Standard Error of the Mean
0-4	10	1.10	.49	.16
5-12	30	1.08	.41	.08
13-24	46	.97	.43	.06
>24	16	.81	.36	.09

This table does not include 32 individuals below age 10 who had no pigment and 12 other individuals with no recorded time of autopsy. Pigment ratio for each case is the observed pigment concentration/age mean pigment concentration. The denominator is obtained from the linear function in figure 2. The average pigment ratios $\pm 2\sigma$ mn. overlap. Hence, no significant differences are demonstrated.

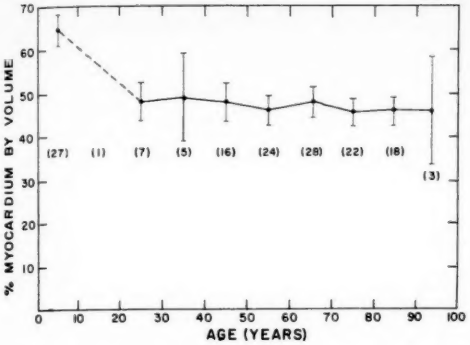

Fig. 1. Percentage myocardium by volume vs. age.
. . . . decade averages ± 2 σ mn.
The numbers in parentheses refer to the number of cases.

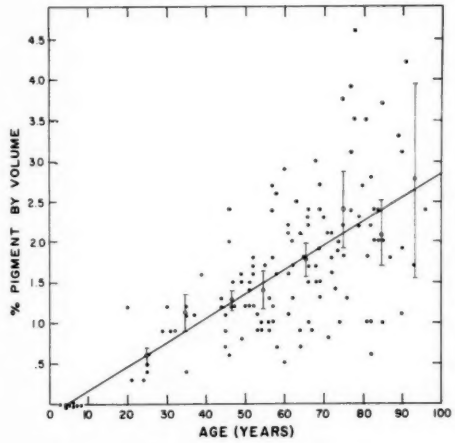

Fig. 2. Percentage pigment by volume vs. age.
• individual cases.
o decade averages ± 2 σ mn.
Linear regression data:
N = 156 $r = .761$ $p < .001$
$\bar{x}$ (mean age) = 51.8 yrs slope = .0285% pigment by vol./yr.
$\bar{y}$ (mean per cent pigment by vol.) = 1.43%

ference from the others. Thus, there is a general homogeneity, but occasionally different areas or sections of a heart may not be identical. In order to minimize variation, all subsequent measurements were made on sections from the apical region of the left ventricle.

Absence of Post-Mortem Changes in Pigment Concentration. The possibility existed that the pigment particles might be artifacts of autolysis or that their concentration might be influenced by the autopsy schedule. Accordingly, the interval between time of death and time of autopsy recorded in the autopsy record (which approximates the time interval between death and fixation of the tissue) was plotted against pigment concentration. There was no correlation between pigment concentration and the time elapsed from death to autopsy (1-130 hours). This observation and the observation that infarcted areas of myocardium contain pigment imbedded in scar tissue suggests that the pigment, once deposited, is not subject to autolysis. The relationship between autopsy interval and average pigment concentration normalized to age is shown in table 4.

Relative Myocardial Volume. It seemed possible that variations in the relative volumes of interstitial tissue or artifacts due to mechanical separation of fibers might produce spurious results. Therefore, the percentage of grid intersections overlying myocardium was determined for each section as above (fig. 1). This autopsy group chosen at random shows no significant change in the average percentage of the total heart volume occupied by myocardium after maturity (fig. 1). However, there is a fairly large coefficient of variation which is not correlated with age.

Pigment Fraction. Figure 2 demonstrates the approximately linear increase in average amount (percentage by volume) of pigment after age 20 in 124 cases ($p < .001$). No pigment was observed in any of 32 cases below age 10. Unfortunately no suitable autopsy cases in the second decade were available in this hospital sample.

The individual pigment values were divided by the relative myocardial volume. The result thus obtained represents the percentage of the myocardium occupied by pigment and is plotted against age (fig. 3). A similar linear relationship to that in figure 2 is evident with about two times the slope. The total amount of pigment/heart also increases linearly with a rate constant of approximately 100 mg./year (fig. 4). This is obtained by multiplying the heart weight by pigment percentage, assuming a heart and pigment density of one. Preliminary studies of pigment centrifugation through density gradients indicate that this assumption is reasonable.

The last two calculations do not decrease the absolute scatter about their respective means.

The large scatter at advanced age is a true one, for it is significantly greater than variations in the measurement (table 2).

The lack of correlation between heart size and pigment concentration is shown in figure 5.

Sex and Race. In order to compare the effect of sex, race, and disease on pigment concentration, one must first normalize for the above-mentioned age-dependent variation in pigment concentration. To do this we constructed a straight line through the decade average points of figure 2. This line gave an hypothetical average value for pigment concentration at each age. The pigment value for each case was then divided by the appropriate age average, giving a ratio near unity for each case.

The individual ratios thus obtained, when grouped according to sex and averaged (table 5), were not significantly different. It is of interest also that the decade means for males and females tend to increase with age at approximately the same rate.

Similarly, no significant difference according to race is apparent (table 5).

Specific Diseases. The individual pigment ratios were grouped according to their cardiovascular anatomic diagnoses and averaged. Cases with more than one disease were grouped in all indicated categories (table 6). No significant differences were demonstrable between the pigment ratios of normal and abnormal hearts for all diseases for which a standard error could be calculated.

Lipofuscin content is said to be increased in hemochromatosis (7, 8). To test this contention 4 additional cases obtained from the Pathology Department of the Johns Hopkins Hospital were assayed. There is no significant difference between the normalized average pigment concentration of the 5 cases of hemochromatosis and the normals.

The low values for our single cases of bacterial myocarditis and systemic lupus and the high values for our single cases of coronary arteritis and hypokalemia could not be studied statistically. None of these individual values, however, were greater than the extreme values obtained for other diseases or for normal people.

Heart Failure. In this series of 156 cases, 55 exhibited the following evidence of heart failure: pulmonary congestion and left ventricular dilatation (left heart failure 20 cases); hepatic congestion, peripheral edema and right ventricular dilatation (right heart failure 12 cases); both pulmonary and hepatic congestion and edema

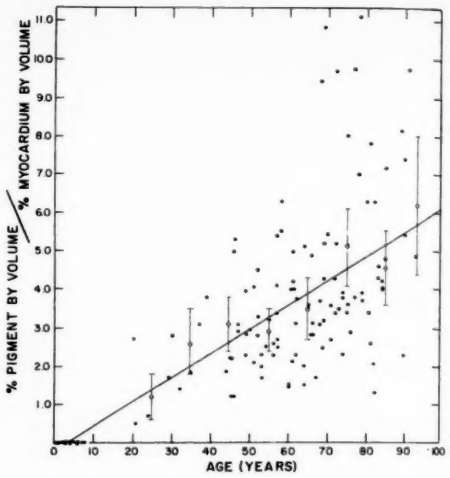

Fig. 3. Percentage pigment by volume/% myocardium by volume vs. age.
• individual cases.
o decade averages ± 2 σ mn.

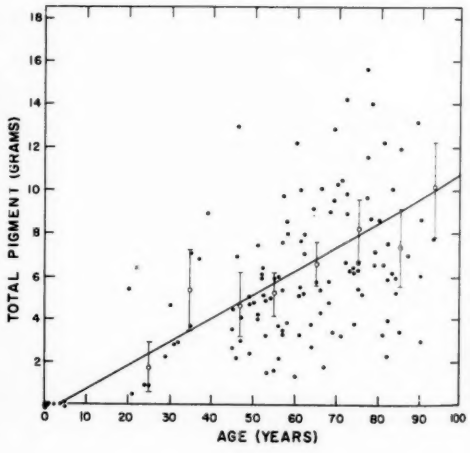

Fig. 4. "Total pigment" vs. age. The total pigment was estimated by multiplying percentage pigment × heart weight (Gm.) x 10^{-2} (assuming pigment density = heart density = 1.0).
• individual cases.
o decade averages ± 2 σ mn.

TABLE 5. RELATION OF SEX AND RACE TO LIPOFUSCIN CONCENTRATION.

Group	No. of Cases	Average Pigment Ratio	Standard Deviation	Standard Error of the Mean
Males	69	1.01	.41	.05
Females	55	1.05	.41	.06
Negroes	52	1.06	.44	.06
Whites	71	1.00	.35	.04
Indian (American)	1	2.00	—	—

This table does not include 32 individuals below age 10 who had no pigment. The average pigment ratio is calculated as described in table 4 and in the text. The average pigment ratios $\pm 2\sigma$ mn. overlap. Hence, no significant differences are demonstrated.

TABLE 6. RELATION OF CARDIAC PATHOLOGY TO LIPOFUSCIN CONCENTRATION.

Condition	No. of Cases	Average Pigment Ratio	Standard Deviation	Standard Error of the Mean
Normal heart	25	1.04	.51	.10
Endocardial disease:				
Mural thrombi	6	.99	.29	.12
Bacterial endocarditis	3	1.14	.39	.23
Rheumatic endocarditis	3	.84	.09	.05
Myocardial disease:				
Congenital (septal)	3	1.10	.36	.21
Metabolic:				
Hypokalemia	1	1.60	—	—
Fat infiltration	3	1.16	.46	.27
Neoplastic (metastatic)	4	1.15	.13	.07
Vascular:				
Coronary arteriosclerosis				
No narrowing	24	1.02	.19	.04
Narrowing	8	1.23	.69	.24
Infarct or fibrosis	32	.97	.35	.06
Circumscribed fibrosis	5	1.13	.54	.24
Coronary arteritis	1	1.60	—	—
Coronary embolism	1	1.10	—	—
Hypertension:				
Pulmonary	10	1.00	.32	.10
Systemic	8	.82	.30	.11
Myocarditis:				
Bacterial	1	.44	—	—
Rheumatic	3	.84	.09	.05
Systemic lupus	1	.80	—	—
Idiopathic	12	1.15	.35	.10
Miscellaneous diseases affecting the Myocardium:				
Idiopathic hypertrophy	3	.94	.27	.16
Amyloid	1	1.20	—	—
Hemochromatosis*	5	.49	.51	.23
Anemia:				
Hemolytic	3	.73	.06	.04
Non-hemolytic	4	.86	.30	.15
Pericardial disease:				
Pericarditis:				
Tuberculous	3	.85	.13	.08
Miscellaneous (acute, chronic)	4	.93	.15	.08
Pericardial effusion	8	1.00	.38	.13

* Because of special interest in Hemochromatosis, 4 cases were obtained from the Pathology Department of the Johns Hopkins Hospital and included.

This table does not include 32 individuals below age 10 who had no pigment. When more than one condition was present, a case was grouped in all indicated categories. The pigment ratio is calculated as described in table 4 and in the text. The average pigment ratios $\pm 2\sigma$ mn. overlap. Hence, no significant differences are demonstrated.

TABLE 7. RELATION OF TYPE AND DURATION OF HEART FAILURE TO LIPOFUSCIN CONCENTRATION.

Condition	No. of Cases	Average Pigment Ratio	Standard Deviation	Standard Error of the Mean
Normal heart	25	1.04	.51	.10
No heart failure	75	1.08	.44	.05
Heart failure	49	.95	.32	.05
"Left sided"	19	.95	.30	.07
"Right sided"	11	.82	.38	.11
"Both sided"	19	1.05	.28	.07
Heart failure prolonged (≥ 1 yr.)	16	.90	.32	.08

This table does not include 32 individuals below age 10 who had no pigment. The pigment ratio is calculated as described in table 4 and in the text. The average pigment ratio $\pm 2\sigma$ mn. overlap. Hence, no significant differences are demonstrated.

TABLE 8. RELATION OF LIPOFUSCIN CONCENTRATION TO THE PREVALENCE OF HEART FAILURE.

Condition	Total Number	No. with Failure	% with Failure	
Pigment concentration > average (Ratio > 1.00)	60	21	35	t = .91 p = .36
Pigment concentration < average (Ratio < 1.00)	63	27	43	
Pigment concentration average	1	1		
Pigment concentration » average (Ratio ≥ 1.2)	39	10	26	t = 1.7 p = .09
Pigment concentration « average (Ratio ≤ 0.8)	41	18	44	

This table does not include 32 individuals below age 10 who had no pigment. The pigment ratio is calculated as described in table 4 and in the text. No significant differences are demonstrated.

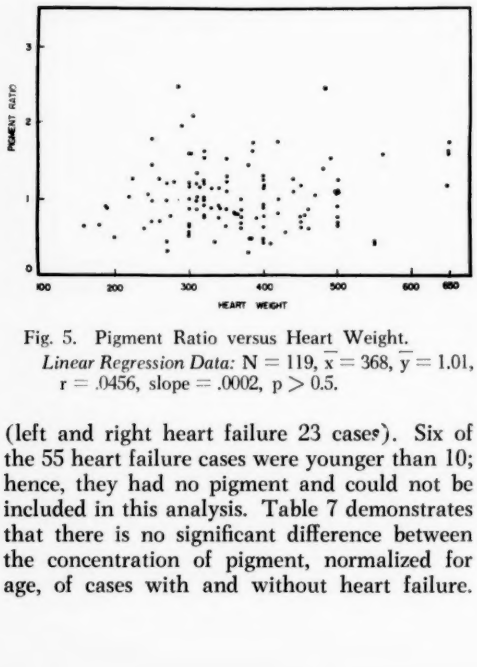

Fig. 5. Pigment Ratio versus Heart Weight.
Linear Regression Data: N = 119, $\bar{x} = 368$, $\bar{y} = 1.01$, r = .0456, slope = .0002, $p > 0.5$.

(left and right heart failure 23 cases). Six of the 55 heart failure cases were younger than 10; hence, they had no pigment and could not be included in this analysis. Table 7 demonstrates that there is no significant difference between the concentration of pigment, normalized for age, of cases with and without heart failure. Moreover, the clinical type or duration of heart failure did not influence the concentration of pigment. The separate analysis shown in table 8 indicates that individuals with pigment concentration above or below their age-specific average have essentially equal probabilities of manifesting signs of heart failure.

DISCUSSION

A primary objective of research in the biology of aging is the identification of time-dependent changes in structure and function which contribute to the progressive increase in the probability of death characteristic of aging animals (12, 26). In order to assess the importance of a given physiological or anatomical change in the aging process, it has seemed reasonable to us to adopt tentatively the following criteria of biologic aging:

I. *Universality.* The change should occur universally in all old animals of a species and should be essentially absent in the very young.

II. *Time dependence.* The change should proceed gradually in an individual and in a population.

III. *Intrinsicality.* The change should be a consequence of the action of time on the innate properties of the biological system rather than a result of a preventable disease, accident, or pathology.

IV. *Deleteriousness.* The change should be unfavorable in its effect on the survival capacity of the individual organism in its normal environment. The change should be of such magnitude that it could contribute substantially to the functional debility of an old organ and its host.

None of the known time-dependent changes in biological systems have rigorously been shown to meet these 4 criteria. Changes in tissue calcium level (2), in the elastic properties of connective tissue elements (13, 29), in the collagen-hexosamine ratio (24), in the numbers of parenchymal cells (1, 9) or in the genetic constitution of non-dividing cells (10) are in principle not excluded as possibilities according to these criteria, but their quantitative importance in the deleterious effects of the aging process cannot currently be evaluated.

The findings of greatest interest and novelty in the present study are, first, the fact that these pigments increase progressively at an approximately constant mean rate throughout life and, second, that they may occupy as much as 10% of the intracellular volume of the heart muscle cells. The first finding cannot be checked in a longitudinal study, but there seems to be no *a priori* reason for doubting that the gradual increase shown in the cross sectional studies here reported parallel the changes in an individual.

The magnitude of the latter finding, particularly, suggests that a definite effect of these pigment granules may be expected. Three alternative possibilities present themselves:

1. The pigment may interfere with the efficient function of the heart muscle.
2. The inclusions may represent some advantageous functional unit developed to compensate for some other loss; for example, the particles may act as a binding agent between contractile elements.
3. These bodies may not affect function appreciably either positively or negatively.

Of these alternatives we consider the first to be the most likely; that is, so large an effect is likely to reflect or cause some impaired function. The granules have been reported to be relatively solid (16) and insoluble (5, 7, 17). Their homogenous fluorescence supports this viewpoint. Therefore, they may represent as much as 30% of the total solids of a muscle fiber (assuming approximately 30% intracellular solids). The replacement of one-third of the functional mass of a muscle with a non-contractile agent could certainly result in a change and probably an impairment of cardiac performance.

This pigment accumulation, because of its magnitude, could meet the criterion of deleteriousness (criterion IV). It might be argued that the lack of correlation between pigment accumulation and the incidence of heart failure is evidence that the pigment does not produce a deleterious effect. Thus, it may be that, despite the appreciable volume they occupy, these pigment granules produce no functional impairment.

However, the opposite viewpoint is also tenable because anatomical evidence of heart failure may be an insensitive test of diminished cardiac functional capacity for two reasons. First, failure occurs when demand exceeds maximum capacity and those challenges that produce failure may considerably exceed the maximum capacity of hearts, whether pigment-laden or not. Second, there are mechanisms other than congestive failure (for example, arrhythmias, sudden arrest, etc.) by which an impaired heart could affect the survival capacity of an individual organism. Unfortunately our data do not permit a final decision with respect to these two alternatives.

That the criterion of time-dependence (II) is met is clearly indicated by the constant rate of pigment accumulation beyond the second decade.

The apparent lack of correlation with specific cardiovascular diseases and heart failure is compatible with criterion III (innateness), although it is conceivable that some unknown pathological state produces the effect. (Various reports on nutritional (19, 28) and pharmacological (28) influences on pigment may have some bearing on this question. But, in the absence of quantitative evidence, these must be considered primarily as matters for speculation.)

The remaining criterion of universality (I) cannot be asserted absolutely since one cannot

test all individuals. From this and all previous studies (14, 17), however, we find no reason to doubt the qualitative consistency of the effect.

The apparent satisfaction of the criteria set forth leads us to the tentative conclusion that age-pigment accumulation does indeed reflect a basic biological aging process, not merely an age-correlated process, however important these latter may be in determining mortality. The lack of correlation with heart failure indicates that it is not formed secondarily to failure.

The lack of differences based upon sex or race further underscores the probability that this is a true aging phenomenon and suggests that its presence is not associated with sex-specific hormones or melanin metabolism.

One might speculate further that the apparent universality and disease independence of pigment accumulation with advancing age indicate a relationship to a biochemical process present in all hearts. The constant mean rate of accumulation of pigment suggests that it is deposited as the result of a zero order process with individual variation in the values of the rate constants. Such kinetic behavior could result from either a constant or a saturating concentration of pigment precursors.

In order to elucidate the nature of the pigment, we are currently engaged in isolating it. The effect of acute and chronic radiation exposure is also being studied in order to test the suggestion that radiation may accelerate certain aspects of normal aging.

SUMMARY

The amount of age pigment has been measured in microscopic sections from 156 human hearts by the use of a random shot fluorescence microscopy technique. No pigment was demonstrated in hearts of individuals below age 10. Hearts of all older individuals had pigment.

The average pigment concentration increased linearly at a rate of approximately 1/3% heart volume/decade. The fraction of the myocardium occupied by pigment and total cardiac pigment also showed linear rates of increase with time (2/3%/decade and 100 mg./heart × year, respectively.)

Pigment concentration was independent of sex, race, cardiac pathology (including hemochromatosis), or the presence or absence of failure. The lack of correlation between heart size and pigment concentration suggests that brown atrophy is not a discrete entity but a fortuitous combination of independently assorting variables (i.e., heart weight and pigment concentration).

The average percentage of heart volume occupied by myocardial fibers remained constant after the second decade.

Because of its absence in the very young, its presence without exception in the aged hearts studied, its lack of correlation with specific cardiac diseases or heart failure, and its large displacement of myocardial volume, the accumulation of lipofuscin in the human myocardium seems to meet the criteria set forth for a basic biological aging process.

Note Added in Proof:

Recently, with the kind cooperation of Dr. Benjamin Castleman, we have examined the heart sections of two cases of progeria (ages 7½ and 11) from the pathology files of the Massachusetts General Hospital. No fluorescent age pigment was detected in either case.

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CELLULAR PROLIFERATION IN THE KIDNEYS OF YOUNG AND SENILE RATS FOLLOWING UNILATERAL NEPHRECTOMY*

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Following unilateral nephrectomy in white rats Sulkin (7) found a greatly increased incidence of mitosis in tubular epithelia of the remaining kidney, which reached a peak 72 to 240 hours following the operation. The increased frequency of binucleate and polyploid cells in these tubules was also described. In the same year and for the same animal Rollason (6) emphasized the role of cellular hyperplasia in individual nephrons in enlargement of the remaining kidney. However, he found this mechanism restricted largely to the second day after the operation. An investigation of renal hyperplasia in white mice following unilateral nephrectomy by McCreight (5) involved determination of the rate of mitotic activity in control and remaining kidneys of young adult animals. Colchicine was employed as an enzyme poison to halt mitosis at metaphase and allow accumulation of mitotic figures for definite intervals of time. Mitotic activity in remaining kidneys had increased significantly over that found in the control kidneys.

Although mitosis often is seen in abundance in developing tissues and organs, in most tissues of normal mature animals the rate of proliferation is quite small and difficult to determine. The time of maturity of an animal certainly cannot be considered synonymous with birth. Flexner (2) compares the long gestation period of the guinea pig with the relatively short gestation period of the rat and considers the former to be a very mature animal at birth, while the latter by contrast is very immature at birth. Further consideration must be given to the difference in stages of maturation of individual organs at any one period of development. Rollason (6) reported considerable mitotic activity in tubular epithelia of rats of two weeks of age, which diminished constantly to a small incidence of mitosis after 56 days. At this time the rats were well over two months of age and could be considered young adults. In normal kidneys of rats 90 days of age Sulkin (7) found mitotic figures to be infrequent. McCreight and Andrew (4) counted mitotic figures in the normal epidermis of two strains of young adult mice and found them to be very rare. Walker (8) studied cellular proliferation in the transitional epithelium of the bladder of mice and reported a high incidence of mitosis at birth, which had diminished at two weeks of age and reached a very low level in adult animals.

There are very few data on the ability of cells in senile organisms to proliferate. The work reported here was performed in order to compare cellular proliferation in renal tubules of young mature and senile animals under both normal and induced circumstances.

MATERIALS AND METHODS

The 4 senile albino rats used in this study were of the C. F. Nelson strain and ranged from 1160 to 1170 days of age. Since birth these animals, of a specific germ-free strain, had received special handling, including air-conditioned quarters, balanced diet, and constant supervision. Only specimens in apparently good health were employed. Six young rats had received identical care and ranged from 120 to 125 days of age at the time of the experiment.

Following ether anesthesia the left kidney was removed by an intraabdominal approach from each of the young rats and the old animals. These kidneys were sliced and immediately preserved in formalin to serve as control organs. Seventy-two hours after the operation each animal was sacrificed by an overdose of ether, and the remaining kidney was removed, sliced, and placed in fixative. Paraffin embedded blocks of the kidneys were sectioned at 10 μ, and the sections were stained by the Feulgen method and counterstained with fast green for study of nuclear detail.

Mitotic rhythm in the rat has been investigated by Blumenfeld (1), who pointed out that mitosis occurs more frequently during the nor-

Submitted for publication June 9, 1959.
* This investigation was supported in part by a grant (B-342) from the National Institutes of Health, Public Health Service, and in part by the Fluid Research Fund of the Bowman Gray School of Medicine.

mal resting period of animals. Therefore all operations and sacrifice were performed at 10:00 A. M.

Observations of mitoses were limited to the cells of the proximal convoluted tubules, both because of their abundance and because of the vesicular nature of the nuclei of interphase cells, which distinguished them readily from the nuclei of cells in process of dividing. With the use of the oil immersion objective, from 100 to 200 nuclei could be brought into focus in a single field. A total of 2000 cells in fields selected at random for each of the 20 kidneys was considered, and mitoses of the several phases were recorded. Means of the numbers of mitoses per 2000 cells, with their standard errors, for each of the control and remaining kidneys in the two age groups were tabulated.

RESULTS

The occurrence of mitotic figures in the proximal convoluted tubules of the control kidneys of the young rats was rare, ranging from one to three mitoses in the groups of 2000 epithelial cells observed for each of the specimens. The mean number was 2.00 (table 1). The stages of division consisted of prophases and metaphases, with a small predominance of the former. There was apparent wide dispersion of isolated mitotic figures, and only in one instance were two found in a single field.

In kidneys remaining to function three days after removal of the contralateral organ, the incidence of mitosis in the above-mentioned tubules was greatly increased. From 11 to 19 dividing figures were found in each of the groups of 2000 epithelial cells observed for the several kidneys. The calculated mean was 11.83 (table 1). Again prophases were the most abundant of the stages of division, but metaphases appeared only slightly less frequently. A lesser number of clear-cut anaphase and telophase figures were present. Widespread distribution of mitoses was observed generally, and only in a few instances did as many as three division figures appear in a single field.

A comparison of the mean values for mitosis in control and remaining kidneys of the young rats (table 2) revealed an almost 7-fold increase in numbers of dividing cells in the proximal convoluted tubules of the latter. Calculation of the standard error of the difference of means proved the difference to be highly significant (table 2).

TABLE 1. THE OCCURRENCE OF MITOTIC FIGURES IN THE PROXIMAL CONVOLUTED TUBULES OF CONTROL KIDNEYS OF YOUNG AND SENILE RATS AND OF THE REMAINING KIDNEYS OF THESE ANIMALS THREE DAYS AFTER UNILATERAL NEPHRECTOMY.

Rat Number	Control Kidneys		Remaining Kidneys	
	No. Mitoses/ 2000 Cells	% Cells in Mitosis	No. Mitoses/ 2000 Cells	% Cells in Mitosis
Young Rats — 120-125 Days of Age				
1	3	0.15	19	0.95
2	1	0.05	15	0.75
3	2	0.10	13	0.65
4	3	0.15	12	0.60
5	1	0.05	13	0.65
6	2	0.10	11	0.55
Mean	2.00	0.10	13.83	0.69
S.E.	0.37		1.18	
Senile Rats — 1160-1170 Days of Age				
1	0	0.00	3	0.15
2	0	0.00	2	0.10
3	1	0.05	3	0.15
4	1	0.05	3	0.15
Mean	0.50	0.03	2.75	0.14
S.E.	0.28		0.25	

TABLE 2. A STATISTICAL ANALYSIS OF THE OCCURRENCE OF MITOSIS IN THE PROXIMAL CONVOLUTED TUBULES OF CONTROL KIDNEYS OF YOUNG AND SENILE RATS AND OF THE REMAINING KIDNEYS OF THESE ANIMALS THREE DAYS AFTER UNILATERAL NEPHRECTOMY.

Comparison	Mean No. Mitoses/ 2000 Cells	S.E.	Difference of Means	S.E. of Diff. of Means	Diff./ S.E.†
Control, Young	2.00	0.37	11.83	1.24	9.54
Remaining, Young	13.83	1.18			
Control, Senile	0.50	0.28	2.25	0.39	5.77
Remaining, Senile	2.75	0.25			
Control, Young	2.00	0.37	1.50	0.47	3.19
Control, Senile	0.50	0.28			
Remaining, Young	13.83	1.18	11.08	1.21	9.16
Remaining, Senile	2.75	0.25			

† The difference of means must be at least twice the standard error of the difference of these means in order to prove that a significant difference exists, according to Hill (3).

In control kidneys of the senile rats mitoses of the cells of the proximal convoluted tubules were encountered even much less frequently than in the control kidneys of the young animals. They could, in fact, be considered almost negligible. Among 2000 cells in each of two such kidneys no mitotic figures were found, and in like groups of cells in two other kidneys only one incidence of mitosis was observed for each. The mean number of cells in process of division at the time of operation was only 0.50 (table 1).

Examination of remaining kidneys of the senile rats removed three days following unilateral nephrectomy revealed an incidence of mitosis in cells of the proximal convoluted tubules of two or three figures in each group of 2000 cells. The mean number was 2.75 (table 1). In both control and remaining kidneys of the senile animals the mitotic figures observed were all in either prophase or metaphase stages, and no tendency toward grouping was seen.

Comparison of the mean values of the mitotic counts for control and remaining kidneys of the senile animals showed a substantial and significant increase in mitosis in the tubules of the kidneys which had been left *in situ* for the postoperative period. They were from 5 to 6 times more abundant than in the control kidneys (table 2).

Further comparison of the means of mitosis for the several categories of kidneys (tables 1 and 2) indicated that in spite of the significant increase in cell division in remaining kidneys of senile animals over that in the control kidneys, the mean value for those remaining kidneys only slightly exceeded that for the control kidneys of the young animals. The average amount of mitosis in either control or remaining kidneys of the senile animals was significantly less than the corresponding figure for the young specimens (table 2).

DISCUSSION

Regenerative ability constitutes a basic biological problem at any age level. Knowledge of the capacity of cells of very old animals to increase their numbers by mitotic division and thus restore depleted tissues is lacking. The results of the present study indicate a lesser capacity for proliferation of new cells in the proximal convoluted tubules of normal kidneys of senile rats than in those of normal kidneys of young adult rats. Further studies may show whether or not the incidence of mitosis is notably reduced in other tissues of senile animals.

In senile rats unilateral nephrectomy provides a stimulus to mitosis in cells of the proximal convoluted tubules of the remaining kidney. The increase in rate of mitosis is only slightly less than that seen under similar conditions in young adult rats. However, in view of the paucity of mitosis of these cells in normal kidneys of senile rats, the increased amount in remaining kidneys is still quite small, and the capacity of the tubules of the remaining kidneys to proliferate new cells following removal of the contralateral organ would seem definitely less in kidneys of senile rats than in those of young rats.

Further information as to the actual amounts of mitosis in tubular epithelia of young and senile animals under normal conditions and under conditions designed to stimulate the mitotic process might be gained by allowing the mitotic figures to accumulate for short intervals of time, rather than count only those figures which are present at the instant of sacrifice of the animal.

SUMMARY

The purpose of this study was to compare cell proliferation in the proximal convoluted tubules of one of the kidneys of 6 young adult and 4 senile rats, both under normal conditions, and in remaining kidneys three days following unilateral nephrectomy, which procedure was expected to enhance considerably the mitotic activity.

Mitoses were infrequent among the cells of these tubules in young mature rats, constituting 0.10% of the cell count. In senile rats they were almost negligible, and only 0.03% of the cells were in mitosis.

Mitotic activity in the proximal convoluted tubules of the remaining kidneys of young animals was 7 times as great as in the control kidneys. The cell counts in the remaining kidneys of senile rats showed a 5 to 6 times increase in mitosis over the numbers seen in control kidneys of the same animals.

While the proliferative response was similar and of comparable degree in the kidneys of young adult and senile rats, the actual amounts of mitosis in either control or remaining kidneys differ markedly for the two age groups.

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THE ENOLASE ACTIVITY OF ARTERIAL TISSUE IN INDIVIDUALS OF VARIOUS AGES*

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The present study was undertaken with the purpose of determining the enolase activity of human arterial samples obtained fresh at autopsy from subjects of various ages. In the case of the aortic and coronary artery samples, activity measurements were made both on normal and arteriosclerotic tissue sections of the same blood vessels.

MATERIALS AND METHODS

Seventy-three samples of the aorta (thoracic descending), 66 samples of the pulmonary artery, and 31 samples of the coronary artery were included in the study. After removal of the adventitia the tissue was rinsed briefly with ice-cold isotonic sodium chloride solution in order to eliminate contamination from adhering blood; for the same reason, only tissue portions which on examination were found to contain no blood capillaries were employed for the studies. Five % homogenates were prepared of intima-media samples by homogenization of the tissue for 2 min. in ice-cold isotonic sodium chloride solution with the use of a Pyrex homogenizer. The homogenates were subsequently centrifuged for 10 min. at 4000 r.p.m and the supernatants were employed for the activity measurements. The activity determinations were made by a modification of Warburg and Christian's (3) procedure through measurement of the rate of formation of phophoenolypruvic acid, using 2-phosphoglyceric acid as substrate.

All the reagents used in the experiments were prepared with glass-distilled water. The D(+)-2-phosphoglyceric acid substrate solution was prepared from the barium salt of the compound (Sigma Chemical Co.). A 75 mM stock solution was made by dissolving the barium salt in 0.2 N hydrochloric acid; the barium was subsequently removed by addition of an appropriate amount of potassium sulfate. Because the 2-phosphoglyceric acid solution was found to be unstable at alkaline reaction the pH of the solution was adjusted to 3-4 for storage in the refrigerator. Immediately before use an aliquot of the stock solution was brought to pH 7.4 through addition of sodium hydroxide.

Submitted for publication July 24, 1959.

* Studies on Arterial Metabolism XXV. The investigation was supported by a grant from the National Institutes of Health, Public Health Service (PHS-891) and the Life Insurance Medical Research Fund (G-56-54).

The final millimolar concentrations used in the activity determinations (total volume, 3.0 ml.) were: D(+)-2-phosphoglyceric acid, 2.5; magnesium chloride, 4.2; phosphate buffer, 35.0; the pH of the buffer-substrate mixture was 7.4. An amount of homogenate corresponding to 5 mg. of fresh tissue was employed in each test.

The rate of formation of phosphoenolpyruvic acid was measured at 38 C. by use of a Beckman DU spectrophotometer provided with thermospacer equipment. The change in optical density at 240 millimicrons was recorded at intervals of 1 min. over a 12-min. period, the sample being read against a cuvette with distilled water. The 5-min. increase in optical density observed between 1 and 6 min. was employed for calculation of the enzyme activity. The molar extinction coefficient of 1700 exhibited by phosphoenolpyruvic acid under these conditions of measurement was used for estimation of the quantity of phosphoenolpyruvic acid formed (1). Reagent blanks and control samples without addition of 2-phosphoglyceric acid showed little change in optical density over a 12-min. incubation period.

The observed K_m for D(+)-2-phosphoglyceric acid was 1.4×10^{-3} M. Nearly identical activity values were found in concomitant experiments in which final concentrations of 2-phosphoglyceric acid of 1.25, 2.50, 5.00, and 7.50 mM were used. Except for the first minute of incubation the reaction curve under the standard conditions employed was found to be linear for a period of at least 12 min. A close relationship was observed between the quantities of tissue used and the recorded enzyme activities over a 5 to 20 mg. tissue range. Because only 2 to 5% of the substrate was converted to phosphoenolpyruvic acid under the conditions of the enolase activity determinations interference by

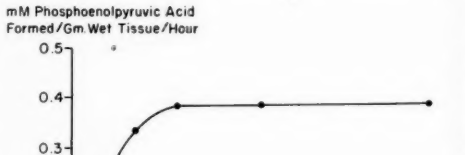

Fig. 1. Effect of magnesium chloride concentration on the enolase activity of arterial tissue homogenate.

TABLE 1. MEAN ENOLASE ACTIVITIES OF HUMAN ARTERIAL TISSUE IN VARIOUS AGE GROUPS.

Age Group (Years)	N	Cholesterol, % of Wet Weight	mM Phosphoenolpyruvic Acid Formed/Gm. Wet Tissue/Hour	s.d. of distr.
Normal Aortic Tissue				
0 - 9	6	0.1	0.16	0.07
10 - 19	4	0.2	0.23	—
20 - 29	5	0.2	0.24	—
30 - 39	12	0.3	0.29	0.06
40 - 49	14	0.4	0.29	0.12
50 - 59	16	0.5	0.26	0.08
60 - 69	12	0.5	0.26	0.07
70 - 79	4	0.5	0.20	—
Grand Mean	—	—	0.26	0.09
Arteriosclerotic Aortic Tissue				
10 - 19	2	0.3	0.30	—
20 - 29	3	0.3	0.31	—
30 - 39	6	0.7	0.24	0.11
40 - 49	10	0.9	0.29	0.09
50 - 59	14	1.2	0.25	0.10
60 - 69	9	1.1	0.24	0.10
70 - 79	3	1.4	0.34	—
Grand Mean	—	—	0.27	0.09
Pulmonary Artery Tissue				
0 - 9	4	0.2	0.16	—
10 - 19	4	0.1	0.27	—
20 - 29	4	0.2	0.27	—
30 - 39	10	0.2	0.26	0.10
40 - 49	12	0.2	0.29	0.08
50 - 59	16	0.3	0.28	0.07
60 - 69	12	0.3	0.28	0.09
70 - 79	4	0.3	0.30	—
Grand Mean	—	—	0.27	0.09
Normal Coronary Artery Tissue				
10 - 19	1	0.1	0.37	—
20 - 29	2	0.2	0.24	—
30 - 39	6	0.3	0.24	0.10
40 - 49	7	0.3	0.19	0.06
50 - 59	7	0.7	0.27	0.09
60 - 69	5	0.4	0.20	—
70 - 69	3	0.4	0.24	—
Grand Mean	—	—	0.23	0.09
Arteriosclerotic Coronary Artery Tissue				
20 - 29	1	0.5	0.28	—
30 - 39	2	1.2	0.33	—
40 - 49	5	2.2	0.15	—
50 - 59	7	1.3	0.25	0.07
60 - 69	3	1.9	0.16	—
70 - 79	2	1.5	0.31	—
Grand Mean	—	—	0.23	0.09

phosphoglyceric mutase in the measurements may be assumed to be negligible.

Studies on the effect of the magnesium concentration on the enolase activity revealed essentially similar activity values at a concentration range from 2 to 16 mM. The values observed at these concentrations were notably higher than the activity recorded without magnesium addition (fig. 1).

RESULTS

The mean enolase activities of aortic, pulmonary artery, and coronary artery samples observed for various age groups have been listed in table 1.

Aortic Samples.—As seen from table 1 the average enolase activity value of normal aortic samples from children aged 0-9 years was lower (0.16 mM phosphoenolpyruvic acid formed/Gm. wet tissue/hour) than the mean value observed for samples from adults (0.27 mM phosphoenolpyruvic acid formed/Gm. wet tissue/hour). No significant change in enolase activity with age was found for samples from individuals aged 20-79 years, the coefficient of correlation between age and enzyme activity being — 0.10 ($t = 0.72, N = 63$).

The results of comparisons between the enolase activities of arteriosclerotic and normal tissue portions of the same blood vessels are listed in table 2. It will be seen from the table that the mean enzyme activity of the arteriosclerotic tissue, expressed on the basis of wet tissue weight, was not significantly different from the average activity of the normal tissue.

Pulmonary Artery Samples.—The enolase activities observed for the pulmonary artery samples were in general of the same magnitude as those recorded for the aortic tissue, the average values for samples from children (0-9 years) and from adults (20-79 years) being, respec-

TABLE 2. MEAN ENOLASE ACTIVITIES OF ARTERIOSCLEROTIC TISSUE EXPRESSED IN PERCENTAGE OF ACTIVITIES OF NORMAL TISSUE OF THE SAME ARTERIAL SAMPLES.

Age Group (Years)	N	%	t of diff.
Aortic Samples			
30 - 49	16	101	0.05
50 - 59	14	94	0.48
60 - 79	12	105	0.39
30 - 79	42	99	0.04
Coronary Artery Samples			
30 - 79	19	90	1.86

tively, 0.16 and 0.28 mM phosphoenolpyruvic acid formed/Gm. wet tissue/hour. The coefficient of correlation between age and observed enolase activity for pulmonary artery samples from adults was + 0.10 ($t = 0.72$, $N = 58$).

Coronary Artery Samples.—The mean enolase values of normal coronary artery tissue samples from adult subjects of various ages were found to be of approximately the same magnitude as those found for the aortic tissue. As seen from table 2 no significant difference was observed between the average enolase activities of arteriosclerotic and normal tissue portions.

DISCUSSION

The present study has demonstrated the presence of a notable enolase activity in human arterial tissue. The activity is approximately 50% of that reported for the rabbit brain (2).

SUMMARY

Determinations were made of the enolase activity of 73 samples of the thoracic descending aorta, 66 samples of the pulmonary artery, and 31 samples of the coronary artery obtained from individuals of various ages. In the case of the aortic and coronary artery samples, the enzyme activity measurements were made separately on normal and arteriosclerotic portions of the same blood vessels.

The average enzyme activity values of normal aortic, pulmonary artery, and coronary artery samples from adults, expressed as millimoles of phosphoenolpyruvic acid formed/Gm. wet tissue/hour, were, respectively, 0.27, 0.28, and 0.23. No significant difference was observed between the mean activities of normal and arteriosclerotic tissue portions.

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THE RIBOSE-5-PHOSPHATE ISOMERASE ACTIVITY OF ARTERIAL TISSUE IN INDIVIDUALS OF VARIOUS AGES*

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The presence in human arterial tissue of the hexosemonophosphate shunt was reported in a previous publication from this laboratory (5). The present study was undertaken with the purpose of determining the ribose-5-phosphate isomerase activity of arterial samples obtained fresh at autopsy from subjects of various ages.

MATERIALS AND METHODS

Seventy samples of the aorta (thoracic descending), 55 samples of the pulmonary artery, and 18 samples of the coronary artery were included in the study. After removal of the adventitia the tissue was rinsed with cold isotonic sodium chloride solution in order to eliminate contamination from adhering blood. Ten % homogenates were prepared of intima-media portions of the tissue with the use of 25 mM sodium fluoride solution. In the case of the aortic and coronary artery samples the activity measurements were made separately on normal and arteriosclerotic tissue sections of the same blood vessels.

The ribose-5-phosphate used as substrate for the enzyme determinations was prepared from adenosine-5-monophosphate according to LePage and Umbreit (6) and Horecker (4). The isolated barium compound was found on analysis to contain only 3% of ribulose-5-phosphate; the preparation was stored in dry form in a desiccator at −22 C. The solution employed in the enzyme tests was made by dissolving the barium compound in distilled water, after which the barium was removed by addition of an appropriate quantity of sodium sulfate.

The final millimolar concentrations used in the activity determinations (total volume, 2.5 ml.) were: Ribose-5-phosphate, 2.0; phosphate buffer, 160.0; the pH of the substrate-buffer mixture was 7.4. An amount of homogenate corresponding to 100 mg. of fresh tissue was employed in each test.

The homogenate-substrate-buffer mixture was incubated for 5 min. at 38 C. A 1.0 ml. aliquot of the mixture was removed at 0 and 5 min. and was added to 1.0 ml. of 10% trichloroacetic acid contained in a test tube. After centrifugation, 1.0 ml. of the supernatant was used for determination of the quantity of ribulose-5-phosphate present in the sample. A reagent blank was run with each set of analyses. The measurement of ketopentose phosphate was made by the colorimetric carbazole-cysteine method as described by Bruns (2), using a 40-minute hydrolysis period at 60 C. (3). A Beckman DU spectrophotometer was employed for the colorimetric determinations. The molar extinction coefficient of 30,000 exhibited by the ketopentose under these conditions of measurement (7) was used for estimation of the quantity of ribulose-5-phosphate formed.

The final millimolar concentration of ribose-5-phosphate employed in the tests is similar to that used by Axelrod (1). The rate of isomerization was found to be proportional with time under the conditions of the experiments over a 6 to 8 min. period and for a 50 to 100 mg. tissue range.

RESULTS

The mean ribose-5-phosphate isomerase activities of aortic, pulmonary artery, and coronary artery samples observed for various age groups have been listed in table 1.

Aortic Samples.—As seen from table 1 the average ribose-5-phosphate isomerase activity of normal aortic samples was 3.4 micromoles of ribulose-5-phosphate formed/Gm. wet tissue/hour; the corresponding value expressed on the basis of the tissue nitrogen content was 91. The activity showed a tendency to increase with age, the coefficients of correlation between age and enzyme activity being, respectively, + 0.27 ($t = 2.33$, $N = 70$) and + 0.41 ($t = 3.48$, $N = 70$) when calculated on the basis of wet tissue weight and tissue nitrogen content.

The results of comparisons between the ribose-5-phosphate isomerase activities of arteriosclerotic and normal tissue portions of the same blood vessels are listed in table 2. The mean activity of the arteriosclerotic tissue was found to be significantly higher than the activity of the normal tissue when calculated on the basis of the total number of samples studied.

Pulmonary Artery Samples.—The average activities of pulmonary artery tissue samples were found to be moderately higher than the values recorded for the aortic samples. In contrast to the aortic samples, the activity of the pulmonary artery samples showed no definite change with age, the coefficient of correlation between age

Submitted for publication July 24, 1959.

* Studies on Arterial Metabolism XXVI. The investigation was supported by a grant from the National Institutes of Health, Public Health Service (PHS-891) and the Life Insurance Medical Research Fund (G-56-54).

TABLE 1. MEAN RIBOSE-5-PHOSPHATE ISOMERASE ACTIVITIES OF HUMAN ARTERIAL TISSUE IN VARIOUS AGE GROUPS.

Age Group (Years)	N	Cholesterol, % of Wet Weight	μM Ru-5-P Formed/Gm. Wet Tissue/Hour	s.d. of distr.	μM Ru-5-P Formed/Gm. Tissue N/Hour	s.d. of distr.
Normal Aortic Tissue						
0 - 9	7	0.1	2.0	1.3	48	21
10 - 19	5	0.2	1.9	—	43	—
20 - 29	5	0.2	3.5	—	75	—
30 - 39	9	0.3	3.3	1.9	81	49
40 - 49	14	0.4	4.0	1.6	106	76
50 - 59	14	0.5	4.5	1.7	117	34
60 - 69	12	0.4	3.4	1.2	96	44
70 - 79	4	0.7	2.5	—	81	—
Grand Mean	—	—	3.4	1.7	91	46
Arteriosclerotic Aortic Tissue						
10 - 19	2	0.3	2.7	—	61	—
20 - 29	1	0.3	1.7	—	35	—
30 - 39	3	0.9	3.3	—	76	—
40 - 49	11	0.9	4.6	2.2	149	80
50 - 59	13	1.2	4.5	1.7	146	36
60 - 69	10	1.0	4.4	2.0	145	44
70 - 79	4	1.3	4.9	—	160	—
Grand Mean	—	—	4.3	1.9	138	64
Pulmonary Artery Tissue						
0 - 9	2	0.2	4.5	—	146	—
10 - 19	2	0.2	4.9	—	125	—
20 - 29	3	0.2	4.1	—	136	—
30 - 39	7	0.2	4.2	2.5	119	73
40 - 49	12	0.2	4.2	2.0	117	55
50 - 59	14	0.3	4.6	1.7	130	52
60 - 69	11	0.3	3.6	2.0	106	72
70 - 79	4	0.5	4.0	—	121	—
Grand Mean	—	—	4.2	1.9	121	59
Normal Coronary Artery Tissue						
30 - 79	9	0.3	4.6	2.1	158	67
Arteriosclerotic Coronary Artery Tissue						
30 - 79	10	2.0	4.9	1.8	181	65

and enzyme activity being 0.00 ($t = 0.00$, $N = 55$) when calculated for the wet tissue values and -0.02 ($t = 0.14$, $N = 55$) when expressed on the basis of the tissue nitrogen content.

TABLE 2. MEAN ENZYME ACTIVITY OF ARTERIOSCLEROTIC TISSUE EXPRESSED IN PERCENTAGE OF ACTIVITY OF NORMAL TISSUE OF THE SAME AORTIC SAMPLES.

Age Group (Years)	N	Wet Tissue		Tissue Nitrogen	
		%	t of diff.	%	t of diff.
30 - 49	14	129	0.71	154	1.93
50 - 59	13	100	0.00	122	2.08
60 - 79	14	138	2.02	163	2.75
30 - 79	41	120	2.20	144	3.85

Coronary Artery Samples.—The mean activities of normal ($N = 9$) and arteriosclerotic ($N = 10$) coronary artery samples were, respectively, 4.6 and 4.9 micromoles of ribulose-5-phosphate formed/Gm. wet tissue/hour. The corresponding values calculated on the basis of the tissue nitrogen content were 158 and 181. Sufficient tissue was not available from most of the arteries to permit comparison of ribose-5-phosphate isomerase activities of normal and arteriosclerotic portions of the same vessels.

DISCUSSION

The present study has shown the presence of a moderate, but definite ribose-5-phosphate isomerase activity in human arterial tissue. The activity is of the same magnitude as that reported by Bruns (2) for human serum. Since preliminary investigations by Bruns have revealed an activity of human red blood cells which is about 1000 times higher than the activity exhibited by serum, the possibility exists that the higher ribose-5-phosphate isomerase values observed for the arteriosclerotic aortic tissue portions may be due, at least to some extent, to the presence in the arteriosclerotic tissue of capillaries which were not detectable by macroscopic inspection.

SUMMARY

Determinations were made of the ribose-5-phosphate isomerase activity of 70 samples of the thoracic descending aorta, 55 samples of the pulmonary artery, and 18 samples of the coronary artery obtained from individuals of various ages. In the case of the aortic and coronary artery samples, the enzyme measurements were made separately on normal and arteriosclerotic portions of the same blood vessels.

The average enzyme activity values of normal aortic, pulmonary artery, and coronary artery

samples, expressed as micromoles of ribulose-5-phosphate formed/Gm. wet tissue/hour, were, respectively, 3.4, 4.2, and 4.6. The corresponding values, calculated on the basis of the tissue nitrogen content, were 91, 121, and 158. The activity of the aortic samples showed a tendency to increase with age, whereas no change was observed in the case of the pulmonary artery samples. The mean enzyme activity of arteriosclerotic aortic tissue portions was found to be significantly higher than the activity of the normal tissue.

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BOOK REVIEWS

RESEARCH ON NOVOCAIN THERAPY IN OLD AGE, English translation of seven papers by Anna Aslan and coworkers; C. I. Parhon, C. David, M. Bürger, F. H. Schulz, U. Köhler, and F. Mampel, originally published in German in *Die Therapiewoche* in 1956-1957. Published by Consultants Bureau, Inc., New York, 1959, 72 pages, $12.50.

Five of the 7 papers published in this collection were written by Dr. Aslan and her coworkers. They describe, in enthusiastic language, the "eutrophic" and rejuvenating effects of procaine. Five ml. of 2% procaine (100 mg.) were administered 3 times weekly in series of 12 injections separated by 10-day rest periods over several months or years. They claim to have reversed cerebral arteriosclerosis, obtained improvement in senile Parkinsonism, renewed production of male and female sex hormones, observed healing of keratosis, ichthyosis, repigmentation of existing hair, stimulation of new hair growth, and decrease in general arteriosclerotic symptoms. They also noted improved central nervous system activity, better cardiovascular response to stress, decreased oxygen consumption, and increased muscle power. They found that, in general, procaine reduced the biological age of the treated subjects below the level of the chronological age. They also reported an improvement of the albumin-globulin ratio after procaine treatment. In the treatment of gastric ulcer, asthma or varicose veins, the same dose of procaine was given intravenously and in the treatment of peripheral arterial disease, intraarterially.

Of the last two papers, the one written by Drs. Bürger and Schulz from the Medical Clinic of the University of Leipzig deals with aging in general, and the rejuvenating processes recommended by various investigators starting with Steinach and Voronoff and ending with Parhon's procaine therapy. The other by Köhler and Mampel, from the First Medical Clinic of the University of Halle, discusses short-term experiences with procaine therapy in 75 subjects. They also found procaine therapy effective in many patients, especially when given together with vitamin preparations.

An appendix contains the translation of a paper by Iaroshevskii from the First Leningrad Pavlov Medical Institute. This paper discusses the effects of the intravenous injections of 50 mg. of procaine on the composition of blood in 30 rabbits. He found an increase in hemoglobin, red cell, and white cell count in most of the animals.

The reader, accustomed to the standards commonly used in the design and evaluation of clinical studies in this country, will be hard put to form an objective opinion of the enthusiastic reports of Aslan and her coworkers on their results with procaine therapy. The first impression is to dismiss it all as unscientific humbug. Indeed, the survey of the biological literature reveals no scientific basis for the results claimed for procaine therapy. Following its intramuscular administration, procaine has to be absorbed into the bloodstream before it can be distributed to the various tissues. Because of the relatively rapid enzymatic breakdown of procaine in human plasma (3 to 6 mg./L./min.), little or no procaine will reach the various tissues after the intramuscular injection of the 100 mg. dose used by Aslan and her associates. Of the enzymatic breakdown products of procaine, the first, dimethyl-aminoethanol, has no biological activity, and the second, p-aminobenzoic acid, is an essential metabolite only for certain bacteria.

It seems that most of the benefits attributed to procaine therapy are the results of primarily subjective evaluation of poorly controlled studies. Psychological factors, both on the part of the subjects and the investigators, undoubtedly had an important influence on their outcome.

Despite all this, before rejecting the claims of Aslan and her coworkers as opinionate and ridiculous, it might be worth while to observe the effects of procaine therapy under carefully controlled experimental conditions. It would be essential that in any such study, procaine, p-aminobenzoid acid, and a placebo should be administered with a double blind setup to institutionalized, aged subjects receiving the same diet and living under similar circumstances.

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PANCREATITIS, A CLINICAL-PATHOLOGIC CORRELATION, by Herman T. Blumenthal and J. G. Probstein, Charles C Thomas, Springfield, Illinois, 1959. 379 pages, $9.50.

This monograph, which is based on clinico-pathological observations made at the Jewish Hospital of St. Louis during the last 25 years, in the reviewer's opinion is of definite value because the subject has not been dealt with extensively in other recent publications. Although a complete review of the aspects of pancreatitis was not intended by the present authors the inclusion in the book of a large number of literature references provides a convenient opportunity for the readers to acquire additional information about the subject. It is regrettable that these references contain many typographical errors, but this may of course not detract significantly from the practical usefulness of the supplied reference lists. Consideration is given in the monograph to the age incidence of the disease, and the literature pertaining to the possible relation between the pancreatic elastase and the development of arteriosclerosis is discussed.

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BOOKS RECEIVED

ARTHRITIS, GENERAL PRINCIPLES, PHYSICAL MEDICINE, AND REHABILITATION, edited by Edward W. Lowman, Little, Brown and Company, Boston, 1959, 292 pages, $9.50.

CARCINOGENESIS, MECHANISMS OF ACTION, edited by G. E. W. Wolstenholme and Maeve O'Connor, Ciba Foundation Symposium, Little, Brown & Co., Boston, 1959, 336 pages, $9.50.

JOURNAL OF GERONTOLOGY

VOLUME 14, NUMBER 4
OCTOBER, 1959

Section B

Psychological and Social Sciences, Social Welfare

Edited by

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Entered as second class matter at the post office of St. Louis, Missouri.

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VOLUME 14, SECTION B OCTOBER, 1959 NUMBER 4

A STUDY OF VERBAL ACHIEVEMENTS OF OLDER PERSONS*

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Although many studies using vocabulary tests (Shakow & Goldman, 1938; Thorndike & Gallup, 1944; Fox, 1947; Lewinsky, 1948) reveal few or no changes in old age, little is known about the differential effect of aging upon other verbal abilities. One reason such studies have been limited to vocabulary tests is that most verbal tests have been found to be highly intercorrelated and the intercorrelation can be accounted for by one or two verbal factors. With regard to the aged, however, this is only a supposition, since at the present time little is known about the factorial structure of abilities in later life. It is still uncertain whether this factorial structure remains unchanged, or whether verbal functioning accounts for an increasing part of the total variance of test scores of aged persons. If the latter is true (and the almost unique stability of vocabulary scores may be interpreted as evidence for this assumption) the use of different verbal tests should yield information especially significant for an analysis of the abilities of older persons.

THE TESTS AND THE HYPOTHESES

The study of which this paper is a partial report has been described elsewhere in more detail (Riegel, 1958). The primary purpose of the research was to evaluate a theoretical framework designed to yield a possible explanation for the differential decline of verbal functions during old age. The model was adapted from the studies of Jenkins and Russell (1958) on word association tests and from the studies of Schaefer-Peterson and Jenkins (1957) on intra-individual association structures.

Five tests each consisting of 20 to 33 multiple-choice items were devised. For demonstration purposes one easy item, adapted from the German version of the battery, is given below and expressed diagrammatically in Figure 1.

Synonym Test (S):

GRANARY means the same or almost the same as: stable, market, *silo*,[1] cornfield, harvest.

Antonym Test (A):

STRONG means the opposite of: shy, *weak*, small, light, sick.

Selection Test (Se):

A GRANARY always has: grain, elevator, cellar, mice, *entrance*.

Classification Test (C):

GRANARY belongs with: field, *stable*, farm, *barn*, plough.

(Note that for the Classification Test two response words are to be selected which, together with the test word, can be subsumed under the supraordinate word "building," or "farm building." This supraordinate word need not be explicitly identified by the subject. No other subordinations of the test word and two response words are possible.)

Analogy Test (An):

GRANARY is related to CORN as STABLE is related to: field, *cows*, grain, cottage, farmer.

Figure 1 contains all test and response words pertinent to the demonstration. Other words, even though they may be more closely associated with the test word, have been excluded, since the present paper deals only with a differential comparison between possible response words.

It was hypothesized that associations between words which are related logically from the linguistic point of view (e.g., synonyms, coordinates, supraordinates, and subordinates) would be strengthened with increasing age by the continuous accumulation of information and by the individual's adaptation to linguistic

* This investigation was aided by the Foundations' Fund for Research in Psychiatry, and was conducted at the Psychological Institute of the University of Hamburg. The investigator is indebted to the Foundations' Fund, Dr. C. Bondy, Director of the Psychological Institute, and to Dr. Ruth M. Riegel for various help and suggestions.

[1] In English, the words "granary" and "silo" are not synonyms, but in translating this item from the German, no better approximation was found.

patterns. If this is correct, then older persons should have an advantage on tasks in which these associations are used. These associations play an especially important role in the Synonym Test, because only a very limited number of synonyms exist for a given word in any language.

In the Selection Test a subordinate word must be related to its supraordinate; or, more generally speaking, the correct response word must denote something which is always characteristic of the thing referred to by the test word. A great number of possible associations exists for a given test word, but only one can be the correct answer on the test. Accordingly, even if all possible associations become strengthened during life, thus giving some advantage to older persons, this phenomenon would be less significant for performance on the Selection Test than on the Synonym Test.

Older persons have still less of an advantage on the Analogy Test. Here not only must a specific relationship be recognized, but this relationship must also be generalized and transferred to a different association, one which may be far removed from the first. The more remote the new association, the smaller will be the advantage for older persons.

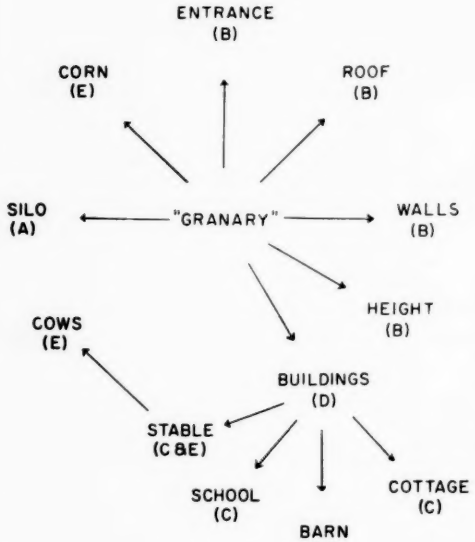

Fig. 1. Associative links of the test word GRANARY to possible response words of four verbal tests. (A), response word of the Synonym Test; (B), possible response words of the Selection Test; (C), possible response words of the Classification Test; (D) supraordinate for the response words of the Classification Test; (E), test words and response word of the Analogy Test.

The theoretical framework outlined above may also be stated in terms of information theory, referring especially to the concept of redundancy. The redundancy of some information is demonstrated by the degree to which the elements of a sequence can be predicted by knowing the preceding ones. In this paper redundancy refers to the association structure demonstrated in Figure 1. All words shown in the Figure have a certain probability of being evoked by the test word, i.e., have a certain redundancy in relation to the test word. As discussed above, these probabilities differ according to the task involved in each test. The probabilities progressively decrease for the Synonym, Selection, Classification, and Analogy Tests. If the association structure becomes increasingly strengthened by the accumulation of experiences during a lifetime, then older persons have an increasing advantage the more the tests require the use of redundant information.

From the association model outlined above a system of null hypotheses was deduced which may be summarized as follows:

$$\bar{\mu}_{28} = \bar{\mu}_{2A} = \bar{\mu}_{28e} = \bar{\mu}_{2C} = \bar{\mu}_{2An}$$

$$\bar{\mu}_{1j} = \bar{\mu}_{2j} \text{ if } \bar{\mu}_{18} = \bar{\mu}_{28}$$

The 1 refers to the younger age group, 2 to the older age group, and the second index refers to the test used.

RESULTS

A preliminary test of the theoretical framework was made by applying the five measures to 74 persons above the age of 65 years in homes for the aged and to 56 students with an average age of 18.6 years from skilled trade schools in the Hamburg, Germany, area. The sample has been described elsewhere in greater detail (Riegel, 1958). The raw scores on the five measures were converted into standard scores in such a way that the means and the standard deviations of the younger group were equalized. Table 1 shows the comparison between the two age groups. Since equal variances could be assumed (Bartlett Test: $p > .05$), the data were analyzed as shown in Table 2.

This analysis revealed significant differences between the age groups as well as between the tests; thus both null hypotheses stated above

could be rejected. Furthermore, the degree of decline with age was dependent upon the kind of test used, i.e., there was a significant interaction between age and test. Generally, older persons were more handicapped on those tests in which the redundancy between test words and response words was least. Table 3 shows that there were significant differences between the average scores of the older persons on two of four adjacent pairs of tests.

A test by test comparison between the age groups, reported in Table 4, revealed significant differences on all tests except the Synonym Test.

The results have yielded a preliminary test of the theoretical framework. Since, however, only indirect association measures have been used, further research is being directed toward the association process itself. For this purpose word association tests have been used with the subjects of the main study group, using as stimuli the same words as in the five verbal tests. Thus it may be possible to study directly the assumption that the achievements of older persons are favored if the tasks require the use of associations between words related logically from the linguistic point of view. The assumption is supported if older persons tend to produce answers which are more redundant to the stimulus word than the answers of younger subjects. Some supporting evidence has been reported by Woodrow and Lowell (1916) in their comparison between word association frequencies of 1,000 children and 1,000 "mixed adults." These investigators found that the adults made greater use of supraordinations, co-ordinations, contrasts, similarities, and part-whole relations than did the children. However, since the adult subjects were presumably not aged persons, the results are not decisive for our purpose.

Related to the findings of Woodrow and Lowell, a decrease in the use of supraordinates and synonyms has been reported recently by Jenkins and Russell (1958) in a comparison of word association norms on four large samples of younger adults tested in the years 1910, 1925, 1929, and 1952. Thus, age changes may interact with general cultural trends.

In order to substantiate from a different point of view the interpretations of the test results reported here, Ruth M. Riegel made a factor analysis of the data on the 74 older subjects, using Thurstone's centroid method and an orthogonal rotation to simple structure (1957). The correlation matrix is given in Table 5 and the results of the analysis in Table 6. The first Factor seems to represent general verbal intelligence, whereas the second Factor has high

TABLE 1. MEANS AND STANDARD DEVIATIONS OF SCORES ON FIVE VERBAL TESTS FOR TWO AGE GROUPS.

Age Group	The Tests				
	Synonym	Antonym	Selection	Classification	Analogy
Younger					
$\bar{X}$	10.00	10.00	10.00	10.00	10.00
S. D. (N=56)	3.00	3.00	3.00	3.00	3.00
Older					
$\bar{X}$	10.27	8.07	6.16	5.73	5.42
S. D. (N=74)	3.04	2.87	3.82	3.94	3.14

TABLE 2. ANALYSIS OF VARIANCE OF SCORES ON FIVE VERBAL TESTS FOR TWO AGE GROUPS.

Source of variation	d.f.	Sum of squares	Mean sum of squares	F	
Between-persons	129	5932.00	45.98	7.09	$p<.01$
R (age groups)	1	1312.26	1312.26	36.35	$p<.01$
Error (b)	128	4619.74	36.09		
Within-persons	520	3372.55	6.49		
C (tests)	4	696.75	174.19	41.47	p .01
CR (interaction)	4	527.28	131.82	31.39	$p<.01$
Error (w)	512	2148.52	4.20		
Total	649	9304.55			

TABLE 3. *T* VALUES FOR THE MEAN DIFFERENCES BETWEEN ADJACENT VERBAL TESTS FOR THE OLDER PERSONS (N = 74).

Synonym/Antonym	5.79	$p<.01$
Antonym/Selection	4.24	$p<.01$
Selection/Classification	.84	$p>.05$
Classification/Analogy	.63	$p>.05$

TABLE 4. *T* VALUES FOR THE MEAN DIFFERENCES BETWEEN TWO AGE GROUPS ON FIVE VERBAL TESTS.

Synonym	.50	$p>.05$
Antonym	3.72	$p<.01$
Selection	6.21	$p<.01$
Classification	6.75	$p<.01$
Analogy	8.40	$p<.01$

loadings in the Synonym and Antonym Tests, tests for which the correct responses are highly redundant to the test words. The third Factor has been interpreted as a verbal discrimination factor, since it has high loadings in Selection, Classification, and Analogy—tests for which the correct responses are least redundant to the test words.

Finally, the high degree of interaction between tests and age groups and the significant results on the within/between-persons comparison (Table 2) suggest that the battery may be useful for clinical purposes, namely, for the detection of pathological intellectual deterioration. The scope of the test battery and the high reliability of the tests may yield a better discrimination between the intellectually deteriorated and other pathological groups than that obtained by instruments presently being used. Studies on feeble-minded subjects and patients with multiple sclerosis are under way.

TABLE 5. INTERCORRELATIONS BETWEEN FIVE VERBAL TESTS (N = 74).

Tests	S	A	Se	C	An
Synonym	—				
Antonym	.75	—			
Selection	.58	.70	—		
Classification	.52	.64	.71	—	
Analogy	.47	.55	.59	.59	—

TABLE 6. FACTOR LOADINGS AND COMMUNALITIES OF FIVE VERBAL TESTS (N = 74).

Tests	Factors			Communalities
	1.	2.	3.	
Synonym	.67	.52	—.01	.71
Antonym	.82	.38	—.03	.82
Selection	.84	.04	.19	.74
Classification	.80	.02	.24	.70
Analogy	.78	—.09	.46	.83

SUMMARY

The theory that associations between words which are logically related from a linguistic point of view become strengthened by the accumulated experiences of a lifetime was investigated by developing five verbal tests in which these associations are of varying importance in solving the problems. These tests were administered to a group of persons above 65 years of age and to a group about 19 years of age. Significant differences were found which appear to support the theory. Further studies are being carried out in which this theory is being tested directly by the use of word association techniques. The test battery will be used further to investigate clinical problems.

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SENESCENT CHANGES IN INTELLECTUAL ABILITY AMONG SUPERIOR OLDER WOMEN*

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The problem of senescent changes in intelligence among superior adults has recently become a matter of some debate. Although Wechsler (1944) showed a marked age decline with normative older individuals, others did not find such decline in the case of bright adults. Nyssen (1953), for example, surveyed the literature on decline and concluded that it is slight among intellectual workers, the loss in vocabulary in this group being practically nonexistent while that in non-verbal ability is appreciable, although less pronounced than in the general population. Sward (1945), testing elderly professors and a control group of younger academicians, used a battery of exacting verbal-mathematical tests and concluded that bright senescents show few unambiguous signs of decided decline. He drew this conclusion despite finding significant differences in most tests favoring the younger men. Sward stressed the points that individual differences are far more impressive than age differences; that loss among older subjects is largely a by-product of disuse and of test artifacts; that in vocabulary, where continued practice favors the old, senescents are uniformly superior; that age impairs rate far more than quality or accuracy; and that one cannot infer that retardation among the superior elderly is generally the rule.

Whereas Sward used a cross-sectional approach, more recent studies using the longitudinal method have attracted considerable attention. Owens (1953) readministered Army Alpha after 31 years to men who had originally taken it in college, and found a significant increase in total score and no significant decrease in subtest scores among his bright subjects. McHugh and Owens (1954) intercorrelated subtest scores for both administrations and factored the resulting matrices. The first factor increased in the second administration, accounting for more of the total variance in 1950 than in 1919; and the authors concluded that with increasing age there is an increase in the general factor underlying the Alpha.

Bayley's longitudinal studies involved a shorter time span than Owens' work; nevertheless, her conclusions were strikingly similar. Bayley and Oden (1955) retested gifted and superior adults, the average age at first testing being 30 and that at the repeat being 42. Using a difficult Concept Mastery Test consisting of synonyms-antonyms and analogies, they also found a significant increase with retest. They concluded that intelligence as measured by the CM Test increases through at least age 50; but added the reservations that they did not cover later ages at which real senescent decrements were to be expected, and that their tests were unspeeded. Elsewhere, plotting age increments from both Owens' work and her own, Bayley (1955) iterated that intelligence, as measured by verbal concepts and abstractions, continues to grow among the superior, but stated that their *patterns* of change may be different from those of the less able.

While Owens and Bayley questioned the adequacy of the cross-sectional method, Wechsler in his latest text (1958) took issue with them, contending that their studies offer no conclusive proof against a generalized age decline. Defending his cross-sectional approach, he stated that it is commonly known that intelligence scores of the superior hold up or improve beyond 25, and that tests employed by Owens and Bayley were primarily verbal,[1] the type which have been shown to fall off least with age.

It would thus appear that the controversy about decline in bright subjects may stem from the nature of the tests used rather than from a particular methodology, i.e., cross-sectional or longitudinal. Owens himself (1953) reported that those abilities which hold up best on cross-sectional samples are the same ones which

* This research was supported in part by the Air Force Office of Scientific Research, Behavioral Sciences Division, while the senior author was Principal Investigator under Contract AF 49 (638)-33, entered into between AFOSR and The University of New Mexico.

[1] Wechsler here obviously referred to the broad grouping into which tests such as the Alpha and CM fall, as distinguished from "non-verbal" or "performance" tests. This usage of "verbal" is different, of course, from the more restricted meaning of the term such as that given in Thurstone's PMAs.

increase most on longitudinal retesting. As noted above, Nyssen (1953) claimed greater loss in non-verbal abilities for bright people. Sward (1945) found his younger men doing better with speeded tests, while senescents were superior in synonyms-antonyms. Other investigators have reported increases in vocabulary with superior older persons when contrasted with younger counterparts. No one, however, has employed a scale using *both* verbal and performance measures in comparing younger and older bright adults. If the Wechsler-Bellevue Scale (Wechsler, 1944) were used in a well-controlled cross-sectional study of such people and important differences were found in these abilities, might it not be inferred that methodology is no more crucial than the type of test used?

The basic problem of the present research, therefore, is concerned with what, if any, would be the differential patterns of bright younger and older subjects on the W-B Scale, Form I, if absolute brightness of both groups were rendered equal. The latter condition involves use of Weighted Test Scores (WTS) rather than IQ, and is necessitated because the IQ has an ineradicable age compensation. Assuming then this equality in ability, should we not expect some sort of compensation in subtests netting this equality? This would be expected if, as Wechsler (1944, 1958) showed, older individuals decline principally in performance tests, and if, as Owens and Bayley maintained, bright persons continue to gain in verbal-type tests. Moreover, which particular subtests would indicate this compensation? Would the "Hold-Don't Hold" (H-DH) dichotomy (Wechsler, 1944) be involved? A related question concerns the comparison of Deterioration Quotients (DQ's) of a superior with a normative group, for as Shock said, "The question of whether a significant decline . . . occurs with age in superior adults is of considerable social importance and should be intensively investigated" (1951, p. 360). Still another problem is that of the relative decline on the 11 subtests for bright people above 60 when contrasted with that of comparably aged average subjects. All of these problems are explored in this study.

THE SUBJECTS

The subjects were normal women chosen from a large group of test volunteers. Individuals with a WTS of 112 or more on the entire W-B I were selected. This cutoff score was used because it corresponds to IQ 110 for the 20-24, or maximally-functioning age group. Thus, only the upper quartile of intelligence was represented, including those whom Wechsler (1944) categorized as Bright Normal, Superior, and Very Superior. The mean uncompensated IQ's for all groups were about 120 (see Table 1).

Women were selected in order to eliminate sex differences, which have been shown to exist in the W-B. In an earlier research, for example, with young superior adults of IQ 120 and above, the senior author (1953) demonstrated marked sex differences in relative patterning. This problem is also discussed by Wechsler in his recent text (1958).

In the design of the study, explained below, it was necessary to use two young groups of CA 19-29; one of 40-49; one of 50-59; and one of 60-and-over. Young Group I comprised 50 *Ss* with a mean age of 22.1 (only two were below 20, however, and close to that age); the mean schooling of this group was 14.4 grades. Young Group II consisted of 75 *Ss* with a mean age of 22.5 (only three under 20 and close to that age); the mean schooling was 14.6 grades. Thus, from the standpoints of mean age and education, both young groups were practically identical.

Because of greater difficulty in securing older volunteers, the three older groups had smaller *N*s. For the group aged 40-49, mean CA was 44.1, and mean schooling was 14.2 grades; for the age group 50-59, mean CA was 54.0, and mean schooling was 15.1; for the 60-plus age group, mean CA was 66.6, and mean schooling was 13.5 grades. The latter group contained six individuals in their seventies and one aged 82.

Thus, the three older groups were separated by about a decade from each other, and their schooling was not too different from those of the younger groups. It must be noted here that the matter of education is important, for failure to control it is a serious criticism of cross-sectional studies. Kuhlen (1940), for example, feels that intellectual decline may in part be attributed to different education for samples of differing ages; and Wechsler says that since the effect of age alone is the real issue in cross-sectional work, it is education which must be accounted for. He adds, "Unfortunately, studies of adult test performance in which education as such has been kept relatively constant for

any considerable age range have been almost entirely lacking" (1958, p. 136).

In order to equate all Ss for brightness (WTS's) the older groups were first matched with each other. Although it was not possible to match precisely, three older groups were obtained with almost equal WTS means and sigmas, as shown in Table 1. Secondly, from a large pool of young subjects, cases were matched on a two-thirds basis (since *N* was 50 for Young Group I) with the older groups, to yield a Young Group I with WTS mean and sigma almost identical with those of the combined older group (Table 1).

PROCEDURES AND FINDINGS

The hypothesis for the first phase of this study was stated in null form: namely, that there should be no significant differences in *patterns* between young and older subjects of equal ability. A test was run by means of Analysis of Variance design for group psychometric patterns (Block, Levine, & McNemar, 1951). Phase 1 of Table 2 presents subtest data for the three older groups and Young Group I; Table 3 gives results from the pattern *AV*. According to this method, if patterns differ significantly among age groups, there should be a significant variables-times-groups interaction. The *F* of 6.47 for 30 *df* (Table 3) was significant beyond the .01 level, and the null hypothesis was rejected. (In Table 3, the significant *F* for variables, i.e., subtest scores, represents significant differences for all groups taken collectively and has no pertinence here. The *F* for individuals is also significant, but since variance for individuals must be extracted as a technical requirement of the method, it also is not basic.)

The scores from Phase 1 shown in Table 2 indicated that the significant pattern differences

TABLE 1. WECHSLER-BELLEVUE (FORM I) SUMMARY DATA FOR ALL AGE GROUPS.

Age Group	N	Scale										
		Verbal WTS		Perf. WTS		Full WTS		D.Q.'s		I.Q.'s[a]		
		M	S.D.	M	S.D.	M	S.D.	M	S.D.	V	P	T
Young Group I	50	62.44	6.57	65.00	5.31	127.42	9.34	93.86	11.56	118	119	121
40-49	25	67.32	4.99	60.84	5.33	128.16	8.50	90.00	10.53	124	114	121
50-59	25	69.88	6.95	59.20	5.43	128.92	9.16	86.64	11.43	127	111	122
60-and-over	25	67.44	6.57	57.24	5.92	125.08	10.28	89.04	13.58	124	109	119
Combined Older-Age	75	68.21	6.34	59.09	5.76	127.39	9.39	88.56	12.00	125	111	121
Young Group II	75	63.55	5.61	63.91	6.69	127.45	9.38	94.28	12.49	120	118	121

[a] I.Q's are based on those for the maximally-functioning age group, 20-24. Therefore, I.Q.'s for older subjects are really Efficiency Quotients.

TABLE 2. MEAN SUBTEST SCORES FOR ALL AGE GROUPS IN TWO PHASES OF THE PRESENT STUDY.

Age Group	Verbal Scale						Performance Scale				
	Info.	Comp.	Diz. Sp.	Arith.	Simil.	Vocab.	Pic. Arr.	Pic. Com.	Blk. Des.	Obj. Ass.	Dig. Sym.
Phase 1											
Young Group I	12.56	13.48	11.10	10.24	14.46	12.92	12.26	13.18	13.32	12.80	13.44
40-49	14.08	13.76	10.92	12.28	14.84	14.76	10.24	12.92	12.96	12.44	12.28
50-59	14.08	14.16	11.08	13.08	15.96	15.20	11.44	12.60	12.12	12.36	10.68
60-and-over	13.84	13.84	10.68	12.92	15.16	14.68	9.88	11.76	12.76	12.40	10.44
Phase 2											
Combined Older Groups	14.00	13.92	10.89	12.76	15.32	14.89	10.52	12.43	12.61	12.40	11.13
Young Group II	13.07	13.72	11.04	10.60	14.49	13.24	11.85	12.91	13.39	12.39	13.37
Differences in Means	+0.93	+0.19	—0.15	+2.73	+0.83	+1.65	—1.33	—0.49	—0.78	+0.01	—2.24
ts	4.08	0.61	0.34	6.28	3.27	7.40	3.44	1.84	2.31	0.03	6.77
p[a]	<.01	—	—	<.01	<.01	<.01	<.01	<.05	<.02	—	<.01

[a] One-tailed test.

could be attributed to differences between Young Group I and the older groups rather than to differences among the latter. Accordingly, a second null hypothesis was tested: that there should be no significant pattern differences among the three older groups. Another pattern *AV* revealed that this hypothesis could not be rejected. In other words, significant pattern differences existed between the young and older groups but not within the latter themselves. Hence, the latter were united to form a combined older group for the second phase of the study. This group had a mean schooling of 14.3 grades, almost identical with the means of each of the young groups.

It now became important to identify, in this second phase, which subtests contributed to the significant pattern difference found. Ideally, the experiment should have been replicated using new groups of subjects. There were enough young cases available to draw a new sample, but practical limitations of obtaining another older sample ruled out this approach. It was decided therefore to contrast the same older groups with a new young sample. Accordingly, a new young person was matched as closely as possible with an older one, and a Young Group II emerged. Referring to Table 1, it may be seen that again the young group was almost identical in WTS mean and sigma with the combined older group.

Examination of mean scores from Phase 1, Table 2, led to specific hypotheses regarding expected subtest differences between the combined older groups and Young Group II. These were that there would be significant differences in means favoring the older group in Information, Arithmetic, Similarities, and Vocabulary; and favoring Young Group II in Picture Arrangement, Picture Completion, Block Design, and Digit Symbol. Since the direction of differences was stated, a one-tailed *t* technique (McNemar, 1955) was used to test the specific hypotheses. Phase 2, Table 2 presents the pertinent data; and it is apparent that, with 148 *df*, all predictions were supported.

TABLE 3. PSYCHOMETRIC PATTERN *AV* FOR YOUNG-AGE GROUP I AND OLDER-AGE GROUPS.

Source of Variation	df	Sums of Squares	Mean Sq. Variance	F
Variables	10	1912.4	191.24	46.13[a]
Groups	3	26.1	8.71	—
Individuals	121	1259.6	10.41	2.51[a]
Variables x Groups	30	804.3	26.81	6.47[a]
Residual	1210	5017.1	4.15	
Total	1374	9019.5		

[a] Significant at the 1 per cent level.

It may be observed from Tables 1 and 2 that the older groups are higher in Verbal (V) than in Performance (P), whereas this is not so in the young groups. It is also apparent that the combined older group is superior to both young groups in V, but inferior to them in P. Null hypotheses were erected to test these observations: i.e., that there should be no significant differences between V and P within both groups, nor between them in V and P, respectively. Two-tailed *t* tests revealed the following information: between V and P means for the combined older group, *t* was 10.36, $p < .01$; between V and P means for the combined young group, *t* was 1.75, $.05 > p < .10$; between mean V's of combined older and combined young, *t* was 7.79, $p < .01$; between mean P's of the same groups, *t* was 8.54, $p < .01$. Thus, the null hypotheses were rejected in three of the four comparisons. There was then a highly significant difference between V and P for the older group; no such difference between the same scores of the young group; a significantly higher V for the older group than for the young; and also a significantly higher P for the young than for the older.

Another question in this study concerned that of rate of mental decline in our older bright subjects. DQ's were calculated according to Wechsler's formula (Wechsler, 1944). Table 1 gives DQ data for the various age groups. It is not surprising to find mean DQ's for both young groups to be, instead of 100, about 94, a figure which makes them appear to be some 15 years more "deteriorated" than their age warrants. The senior author pointed this out in earlier research using superior young adults (Norman, 1953), when he found a DQ of 95 for females, a result explained mostly by their poor scores in Arithmetic. Nevertheless, it was of interest in this study to compare young and older subjects in DQ, and to contrast them with Wechsler's standardization sample (1944).

A null hypothesis concerning DQ's—that there should be no significant difference between our combined old and combined young groups—was tested. The mean DQ for the young was 94.11, that for the older group was

88.56; and the t for the difference was 3.14, $p < .01$. (Simple *AV* of means for the three older groups separately yields no significance, tying in with the previous finding of lack of differentiation among their patterns.) It thus appears that there is a significant loss among these bright females who are older, despite the fact that they were equated for absolute brightness with the younger Ss. Hence, if we examine just the DQ, whatever gains are made by the older bright do not compensate for their losses, and the general trend is significantly downward. However, how does this loss compare with that of Wechsler's normative group?

Curves were plotted showing the decline of Wechsler's group, with DQ's for the 60- and 70-year age groups extrapolated from his data, and our own groups. A fitted curve for our subjects was also derived by least squares. These curves appear in Figure 1, and indicate a slow, steady decline for our subjects as contrasted with the more radical drop for the norm group. Within the limitations of the method, the conclusion is that bright older females decline less than do average individuals. This conclusion must be tentative because of the limited *N*s in each older group, and because Wechsler's older groups contained mostly males. Yet the decline of some seven points in our group contrasts strikingly with that of about 24 points for Wechsler's group over the 50-year period on the W-B DQ. Even if we use the much more recent WAIS female sample (Doppelt & Wallace, 1955; Wechsler, 1958) for the same age span, we estimate a decline of over 20 points, calculated with the revised DQ formula (Wechsler, 1958).

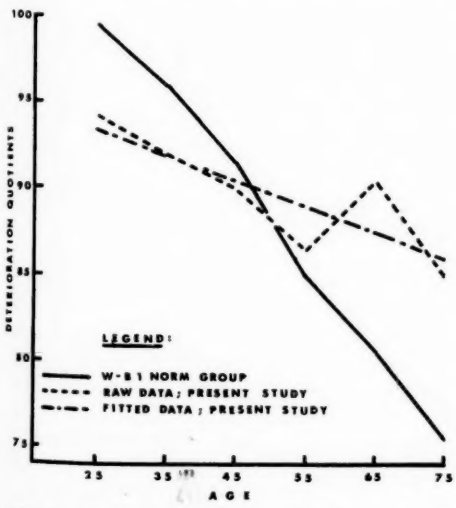

Fig. 1. Comparative decline in DQ of superior females and Wechsler's norm group.

Still another question raised by this study concerns the rank order of decline of subtest scores within our very oldest group compared with the same order for comparably aged average Ss. The subtests for our 60-plus age group were ranked and this order compared with those reported in previous studies. The latter are those by Fox and Birren (1950) for Ss aged 60-69 (mean age, 64.3); by Rabin (1945) for a non-psychotic mental hospital group aged 60-78 (mean age, 65.2); by Madonick and Solomon (1947) for Ss aged 60 to over 80 (estimated mean age, 72); by Chesrow, Wosika, and Reinitz (1949) for Ss aged 64 to 83 (mean age, 72); and by Berkowitz (1953) for veterans in the 60's (estimated mean age, 65). All of these dealt with the average elderly. (Even though Madonick and Solomon give an average *age-compensated* IQ of 115 for their group, their WTS's would be far below those of our group.) One difficulty with these comparisons, however, is that most of the Ss in these studies were males. Therefore, we also ranked subtests for the WAIS female elderly Kansas City sample, aged 60-69, as reported by Doppelt and Wallace (1955).

Results of our comparisons revealed that there was substantial resemblance in rank order between other studies and the present study for all subtests except Similarities, in which case there was an average difference of five ranks. Similarities was first in our group, but held a median of sixth in other W-B studies with the elderly; it also ranked fifth in the WAIS sample. These differences are so sizeable that the Similarities test seems to bear some special distinction.

DISCUSSION

Although the first finding in this study indicated no important differences in patterns or in DQ's among the three older groups when compared with each other, it would be more proper to draw such a conclusion if there had been larger *N*s at the three older age levels. It is suggested that these findings be further explored with greater numbers of cases. For the present, this discussion will focus upon the contrasts between the larger combined older group and the larger young groups.

Data from Table 2 and analysis of V-P differences support strongly the conclusion that, in order to maintain the same relative brightness as a young group, the older group of same educational level must counterbalance in V for loss in P. There was a significant increase among the older in Arithmetic, Similarities, Information, and Vocabulary; and a significant decrease in Picture Arrangement, Picture Completion, Block Design, and Digit Symbol. This pattern, along with the tests that showed no differences between age groups, does not correspond closely with the H-DH dichotomy (Wechsler, 1944). The increase in Arithmetic is interesting, since earlier studies showed that older adults have difficulty with arithmetic tests. Careful work by Birren, Allen, and Landau (1954), for example, using simple addition tasks, revealed that the elderly are slower and less accurate. Even with bright adults, arithmetic abilities reportedly fall off. Owens (1953) found the only Alpha test showing loss to be Arithmetical Reasoning, although this loss was not statistically significant. Sward (1945) reported that his older professors did poorly in numerical tests when contrasted with the younger. (The finding in the present study is also interesting because these subjects were women, and women are significantly poorer than men in Arithmetic [Norman, 1953; Wechsler, 1958].)

Explanations for the discrepancy between these results and those of other studies may lie in the facts that, although educational levels of the young and older groups were the same, the quality of education may have been different for both; that the problems on the W-B are not as difficult as those used by other investigators with older bright Ss; or that, with increasing age, older women may be forced to make more use of their arithmetic abilities. However, it should be added here that evidence is no longer so strong that Arithmetic is a DH test even with normative Ss, as Wechsler (1944) originally maintained, since not only do Corsini and Fassett (1953) report significant increase with age in this test, but also since Arithmetic has been dropped as a DH test from the newer WAIS (Wechsler, 1958).

The gain in Vocabulary is entirely consistent with earlier studies using this type of test with older bright people. Shock, in his review (1951), Garfield and Blek (1952), Sward (1945), Bayley and Oden (1955), and Owens (1953) report similarly. The significant increase in Information is also congruent with the Owens-Bayley findings, although their tests called for different kinds of information. The present investigators therefore agree with Shock (1951) in questioning the long-fixed assumption that vocabulary level in senescence is a good indicator of intelligence at earlier ages; and disagree with Jackson (1955), who thinks Vocabulary and Information provide the best baseline for analysis of W-B impairment. Such agreement and disagreement applies, of course, only to generalizations regarding superior adults. Reports using average subjects (Bayley, 1955; Berkowitz, 1953; Corsini & Fassett, 1953) are inconsistent with regard to the question of vocabulary and informational tests staying constant or actually increasing during the life span.

The increase in Similarities score for older subjects may be surprising, because Wechsler (1944) contended that this test measures abstracting ability, an ability which reputedly declines with age in normals. (Garfield and Blek [1952], note some loss in abstraction among the bright elderly in the Shipley-Hartford Test, but their data are far from conclusive.) Not only was an increase found in this study, but also, as noted earlier, Similarities holds a very high rank when compared with its rank among the average aged. It is possible that a test with such a high loading of "g" (Wechsler, 1944) increases with superior older people, much as Bayley and Oden (1955) found an increase in their Concept Mastery Test, and as McHugh and Owens (1954) found an increase in the general factor underlying Alpha, both studies using longitudinal methods. The results of the present study should also be contrasted with Wechsler's willingness to call Similarities a DH test in the new WAIS (1958).

The loss in Performance tests, most particularly in Picture Arrangement, Block Design, and Digit Symbol, is highly consistent with previous studies on older average Ss (Berkowitz, 1953; Birren, 1952; Chesrow, Wosika, & Reinitz, 1949; Corsini & Fassett, 1953; Fox & Birren, 1950; Howell, 1955; Rabin, 1945; Wechsler, 1944). These three tests are timed, and as Lorge (1936) pointed out, such tests are significantly handicapping to older subjects, even though Howell (1955) argued against Lorge's position for the first two tests. It will

be remembered that Sward (1945) found age affecting rate far more than quality or accuracy among his very superior men. Although in the present study no significant difference was found in the timed Object Assembly, it may be that this test is relatively easy for bright Ss. (Wechsler [1944] reported it as having the lowest correlations with the W-B Scale as a whole.) The significant difference in Picture Completion may be due in part to visual acuity loss among the elderly, a factor independent of intelligence and a point noted by Corsini and Fassett (1953), among others.

However, it is also possible to examine these results more globally from a quite different viewpoint—that of factor analysis. Birren (1952), performing such analysis of the W-B given to the normal elderly, found three important factors: a V (Verbal Comprehension) factor, a function of amount of stored verbal information or meanings; a C (Closure) factor, or ability to fuse the perceptual field into a single percept; and an M (Rote Memory) factor. The V factor had highest loadings in Vocabulary, Information, Similarities, and Comprehension; C had highest loadings in all performance tests; and M had highest loadings in Block Design, Arithmetic, Digit Span, and Digit Symbol, particularly the latter three. Differences between the young and older Ss in the present study revealed that the older gained significantly in three of the four V tests; lost significantly in four of the five C tests; but gave no conclusive pattern in M tests. On the other hand, Birren's average elderly held the same in V, but lost significantly in C and M. It would thus appear that the older superior adults in this study differed markedly from Birren's group in that they made substantial gains in "stored information" and did not lose strikingly in memory. The latter finding is in agreement with Gilbert (1941), who reported her brightest subjects declining both relatively and absolutely less in memory of all types.

Although the H-DH dichotomy did not maintain exactly in this study, there was still a significant DQ drop when comparing older with young Ss, despite holding over-all brightness constant. This decline differs considerably from that derived from Wechsler's norm groups. Howell (1955), attempting to evaluate deterioration of individuals of various levels of education and intelligence on the W-B, calculated deterioration indices for Ss of differing education. Because he found similar indices for these Ss, determined at the senescent period itself, and because he found significant differences among them in compensated IQ's, he suggested the independence of decline from level of intellectual functioning. However, it should be noted that instead of Wechsler's DQ, he contrasted three V with three P tests, a procedure Wechsler (1944, 1958) does not accept. Furthermore, Howell's "college" Ss included persons with *any* recognized formal education beyond high school, such as business or music schools. Thus the present study differs from Howell's with regard to subjects as well as method of approach.

In many ways, the present findings regarding age changes on subtests correspond closely with those obtained from a prisoner group by Corsini and Fassett (1953). However, Corsini and Fassett contrasted ages 15 and 50; and with prison inmates, educational differences between these particular ages could be important. Nevertheless, the present investigators agree with Corsini and Fassett that ability will vary with age downwardly if tests contain visuo-motor factors, and upwardly if they contain material dependent upon continued learning. Thus the results obtained by either the cross-sectional or longitudinal approach in the study of age changes in intellect will certainly be affected by the tests one employs. The questions must be faced of what properly constitutes intelligence, and what sorts of tests one uses to measure it—questions beyond the scope of this study. If, however, the viewpoint is adopted that the type of test is an important issue in the study of aging, then, judging from these findings regarding superior adult women, neither the Owens-Bayley nor the Wechsler positions may be negated, for they both appear to be essentially correct.

SUMMARY

This study compared the intellectual abilities of young and older bright females, with education and absolute brightness well-controlled. Uncompensated Wechsler-Bellevue Form I IQ's all averaged about 120, and mean schooling for both groups was just over 14 grades. It was found that (a) the older are significantly different in patterns from the young, having higher scores in Information, Similarities, Arithmetic, and Vocabulary; and lower scores in Picture Arrangement, Picture Completion,

Block Design, and Digit Symbol; (b) there are significant differences in Verbal and Performance WTS's between the two groups and within the older group; and (c) there is a significant drop in DQ for the older, although this drop appears to be far less than that reported for older subjects of average ability. Finally, (d) in comparison with the average elderly, the Similarities test holds a much higher rank for the bright subjects. The type of tests used in the study of senescent change in intellectual ability is equally as important as methodology, whether longitudinal or cross-sectional.

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TWO FACTOR ANALYSES OF EXPENDITURES OF THE AGED*

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Empirical investigations of consumption expenditures of the aged have been limited to governmental and private studies in which the aged population has been treated as a segment of the whole. In some instances the data have been fragmentary in that they covered only certain types of expenditures, or included only certain cities or areas. A further limitation of these studies is that no continuous data have been collected over a period of time. A trend analysis of expenditures, therefore, cannot be made.

The principal studies which have provided data are the *Survey of Consumer Expenditures* conducted by the Bureau of Labor Statistics (1957), the *Life Study of Consumer Expenditures* (1957), and the study of family spending and saving by the U. S. Department of Agriculture (1942). Several studies involving partial data have also been done by the Federal Reserve Board (1945-1959), and the Social Security Board (1943a; 1943b). The primary purpose of these studies has been to provide information relative to the spending habits of the aged and, in the case of the Social Security Board, to provide budgets for the aged. Some individual community studies have also been made (Brunner, 1955; Millar, 1956), but these are of limited value for the study of the economic problems of the aged at the national level.

Of more importance for putting the theoretical foundation of the economic branch of gerontology upon a firm basis is the establishment of the relationships between income, expenditures, and the demographic variables of the aged population. An analysis of present practices is needed before any program for the improvement of the economic status of the aged can be undertaken.

METHOD

The data used in the present study were taken from the Bureau of Labor Statistics' national study of expenditures in 1950 (1957) which was undertaken to determine expenditures of urban families. In this study cities were chosen randomly from a size of 2500 population to 9 million (New York) and then stratified by area characteristics such as city size, climate, income level of community, and population density. The smaller cities were selected by the use of the Latin Square diagram. Individual families were drawn primarily from dwelling unit survey lists made by the Bureau in 1949 and 1950. Others were taken from addresses furnished by the 1950 census. Area block samples were also used for proportionality.

For the present analysis, those families in which the head of the household was 65 years of age or older were taken from the total sample used by the Bureau. Although the term "family" was used for identification, a number of single individuals, both male and female, were in the sample. The total number of units was 1757, of which 1224 were families with two or more members, 371 were single females, and 162 were single males.

Twenty-six variables were selected from data available on IBM cards prepared by the University of Pennsylvania. The demographic characteristics, the current income, and the expenditures for food, clothing, and shelter of the aged population were used. Some goods classified as durables were included in the third classification. Past and future income were punched in the cards by numbers 1, 2, and 3. These numbers indicated the level of past and future income with relation to present income level. Figure 1 represented a lower level, figure 2 the same level, and figure 3 a higher level of income. Savings were indicated in a similar manner, except that a five-number series was used to denote a range of saving from 25 per cent of income saved to 25 per cent dissaved. This percentage represents the difference between current income and current expenditures for the year in which the data were collected (1950) and is positive when income exceeds expenditures, negative when the reverse is true.

Factor analysis was selected as the analytical technique because this method sorts out the variables upon the basis of their interdependence rather than upon their independence or dependence. Unlike variance analysis, factor

* This study was supported by a research grant from the Committee on Gerontology, University of Illinois.

analysis produces factors which show a functional unity or pattern, the association of the variables, and the degree of this association (Cattell, 1952, p. 10).

To determine the best fit for the variables in each factor, two procedures for rotating were used. The Varimax (Kaiser, 1958) is orthogonal (90 degrees), and the Oblique (Pinzka & Saunders, 1954) rotates at angles other than 90 degrees. The purpose in using two procedures was to compare the factor structures for any marked differences in the patterns.

RESULTS AND DISCUSSION

Eight factors were extracted from the data. Tables 1 and 2 show the rotated factor loadings for each of the eight factors. The factors are identified and discussed below.

Factor 1. Family Size. Certain expenditures, notably for Food Prepared at Home and for Clothing, were shown to be related to the Family Size variable. Income was also an important variable. It was to be expected that expenditures for these items would be greater as family size increases, and that higher expenditures would be realized from higher income.

Factor 2. Future Income. This variable did not show a positive relationship to any expenditure. Instead, it showed a marked negative relationship, especially to heavy expenditures for floor coverings and equipment (appliances, radios, and television sets).

Even with the present high level of income, future income uncertainties, as this variable shows, preclude any unusual outlays that would have to be paid for in the future. The possibility of higher prices also affects decisions, since some reserves must be kept on hand to take care of the higher prices of necessities.

Factor 3. Housing. This factor revolves around expenditures for Owned Dwelling, Utilities, and other costs of operation. In the Varimax analysis, Income, and to a lesser extent Family Size and Age, showed some relationship to these expenditures. In the Oblimax analysis, Education and Age showed a greater relationship.

Factor 4. Recreation. Since many persons 65 years of age and older are retired or perhaps partially employed, they have time for leisure activities. This factor shows high loadings for Other Housing (an expenditure incurred in traveling), Housewares (which vary but do not represent a large individual outlay), Men's Hats and Gloves, and Food Eaten Outside the Home. The last is a mixed expenditure, since

TABLE 1. ROTATED FACTOR LOADINGS: VARIMAX PROCEDURE.

Variable	Factors							
	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
1. Income Bracket after tax	+52	+00	+33	+21	+44	+36	+08	+19
2. Level of Saving	+06	+03	-07	+12	+64	+13	-10	-18
3. 1951 Income Comparison	+05	+44	-13	+15	-22	-02	-26	+25
4. 1949 Income Comparison	-01	+08	-07	-01	-53	+20	-25	-10
5. Years Education	+01	-12	+09	+09	+04	+03	+63	+09
6. Family Size	+74	+03	+21	-14	+10	+18	-18	+11
7. Actual Age	-07	+11	+19	-11	-10	-39	+33	-27
8. Full Time Earners	+44	+16	+10	+04	+51	+31	-07	+17
9. Food Prepared at Home	+64	+03	+34	-21	+17	+31	-02	+24
10. Food Eaten Outside Home	+11	-01	+06	+73	+15	+24	+03	-03
11. Alcoholic Beverages	+14	-00	+06	+10	-01	+65	+07	-05
12. Tobacco	+28	-02	+09	+08	+04	+68	+04	-02
13. Rental Dwelling	-02	+24	-44	+15	+02	+15	+51	+07
14. Owned Dwelling	+14	+00	+73	+17	+08	-09	+00	+17
15. Other Housing	-09	-05	+47	+44	-04	+21	-00	+09
16. Fuel, Light, Refrigeration	+29	-13	+73	-08	+02	+16	-02	-04
17. Household Operations	+11	+11	+61	+23	-07	+14	+36	+10
18. Household Textiles	+20	-16	+20	+04	+02	+03	+04	+68
19. Floor Coverings	+10	-58	-03	+01	-11	+11	+12	+24
20. Furniture	-00	-13	+02	+02	-03	-01	+07	+70
21. Equipment	+15	-49	+06	-04	+25	-08	-16	+24
22. Other Housewares	+13	-43	+16	+41	-08	-01	-12	+25
23. Men and Boys' Outerwear	+72	-15	+07	+38	-02	+17	+08	+07
24. Men and Boys' Underwear	+82	-12	+02	+19	+03	+07	+01	+02
25. Men and Boys' Footwear	+83	-11	+01	+23	+02	+07	+01	+00
26. Men and Boys' Hats, Gloves	+27	+12	+08	+63	+08	-07	+19	+02

it represents entertainment as well as food consumption.

The negative loading for Family Size further illustrates that this factor applies primarily to couples or single individuals, and the low Income loading indicates a divergent type of expenditure.

Factor 5. Income. This factor contains high loadings for both current income and savings, or accumulated reserve. It is supplemented by the high loading of full-time earners, indicating that income sources come from more than one member of the family. The high loading for Savings is indicative of the fact that reserves which have been accumulated from past years during full-time employment are sufficient for drawing upon for current expenditure use. The high loading for Equipment is indicative of this additional resource. In this respect, this older age group is no different from younger age groups, except for the uncertainty of future income and the knowledge that savings may not be replenished.

Factor 6. Age and the Marriage Cycle. This factor shows an inverse relationship to expenditures; that is, as age increases, expenditures tend to decrease. This relationship is especially noticeable since a large percentage of the sample is composed of single individuals. The inverse relationship of consumption of Alcoholic Beverages and Tobacco is most noticeable. This phenomenon may be explained by increasing age, and the presence of large numbers of widows in the sample. Advancing age may also force the curtailment of this kind of consumption for health reasons.

Factor 7. Migration. One of the most notable relationships in this factor is the association of the Education variable with Rental Housing. The higher the educational level, the greater the tendency to rent a home or apartment for living quarters rather than buy a home. This was the only factor in which Rental Housing had a high loading. Further evidence of this phenomenon was found in the negative loadings for utilities (expenditures for which would be included in rent) and purchase of equipment and other housewares, normally found in furnished apartments.

Factor 8. Durables. This factor follows a pattern of expenditures confined mainly to Household Furnishings and Outerwear such as suits and overcoats. This pattern can be explained in terms of changes in needs such as

TABLE 2. ROTATED FACTOR LOADINGS: OBLIMAX PROCEDURE.

Variable	Factors							
	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
1. Income Bracket after tax	+14	-04	+17	+14	+51	+19	-02	+12
2. Level of Saving	-15	-18	-31	+23	+100[a]	+01	-03	-33
3. 1951 Income Comparison	+04	+79	-11	+13	-36	-11	+08	+39
4. 1949 Income Comparison	+13	+29	-09	-02	-77	+42	-12	-12
5. Years Education	+04	-44	+48	-01	+01	+06	+44	+15
6. Family Size	+59	+13	-04	-26	-02	+05	-21	+03
7. Actual Age	+15	-18	+49	-14	-13	-44	-04	-31
8. Full Time Earners	+03	+14	-10	+01	+63	+13	+06	+14
9. Food Prepared at Home	+27	+03	+15	-35	+05	+20	-13	+22
10. Food Eaten Outside Home	+15	+09	+04	+77	+28	+19	+07	-14
11. Alcoholic Beverages	-10	-11	+06	+07	-08	+87	+15	-13
12. Tobacco	-00	-10	+03	+03	-02	+86	+11	-11
13. Rental Dwelling	+07	+01	+08	+07	+01	+20	+89	+20
14. Owned Dwelling	-11	+07	+58	+14	+03	-27	-53	+14
15. Other Housing	-26	+05	+38	+46	-05	+23	-29	+04
16. Fuel, Light, Refrigeration	+02	-20	+51	-13	-08	+14	-60	-18
17. Household Operations	-10	-03	+81	+14	-21	+12	-10	+10
18. Household Textiles	-07	+12	+11	-08	-10	-11	+05	+89
19. Floor Coverings	+19	-49	-11	-06	-19	+22	+07	+27
20. Furniture	-22	+16	+02	-07	-15	-11	+21	+98
21. Equipment	+09	-33	-29	-03	+36	-18	-24	+22
22. Other Housewares	+25	-10	-07	+40	-10	-05	-23	+23
23. Men and Boys' Outerwear	+92	-03	+03	+25	-13	+07	+08	-05
24. Men and Boys' Underwear	+103[a]	-01	-07	+06	-06	-07	+03	-11
25. Men and Boys' Footwear	+107[a]	-00	-08	+10	-07	-07	+04	-13
26. Men and Boys' Hats, Gloves	+47	+19	+23	+60	+12	-25	+16	-04

[a] Although these numbers exceed 1, it must be remembered that they represent loadings rather than correlations. Theoretically in the vector principle loadings could be plus or minus infinity. Rarely does the rotation in the oblimax solution provide such high loadings for a variable, but in some instances it does happen.

a more modest type of housing arrangement, or a difference in clothing caused by a move to another climate. As might be expected, an optimistic attitude toward future income has some relationship to these expenditures. Large or extensive purchases in these areas would not be made if future income was not certain.

SUMMARY

A study of expenditures of urban families and single individuals aged 65 and over showed some interesting factor patterns. Eight factors were operative in the structural pattern of family characteristics and expenditures. Both the Varimax and the Oblique factor procedures confirmed this observation.

The complexity of the behavior of these consumers was demonstrated by the grouping of variables into separate patterns, each of which had a singular function. In six of the factors specific expenditures showed functional interdependence with one or more demographic variables.

It is obvious from these findings that the economic behavior of the aged cannot be predicted with certainty. Any predictions should be used with reservations as to their accuracy, and should be based upon specific expenditures as indicated by the factors themselves. Further research is needed before any generalizations can be stated with respect to the economic behavior of the aged.

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A RESEARCH TREATMENT PROGRAM FOR GERIATRIC MENTAL PATIENTS

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Since the mean age of our mental hospital population is steadily increasing, and the proportion of long-term cases is constantly growing larger, the need is apparent for intensive study of the methods and problems involved in treating the aged chronic mental patient (Bromley, 1956; Kalb, 1956; Morgan & Johnson, 1957). This report describes a particular method and its results after one year of application. The assumption was that a change or a break in the apathy, withdrawal, and negativistic behavior patterns of such patients would require an active enthusiasm, involvement, and optimism on the part of the staff who work with them.

SUBJECTS AND METHODS

The research population consisted of 98 chronic patients residing on two wards of the Geriatrics Service of the Veterans Administration Hospital, Brockton, Massachusetts. The median age of the patients at the beginning of the study was 60 years; the median length of continuous psychiatric hospitalization was 19 years; the diagnostic classifications were: schizophrenic reaction, 75 per cent; chronic brain syndrome, 19 per cent; other, 6 per cent. Through interward transfers, the patients on the two wards were made comparable on the basis of age, length of continuous psychiatric hospitalization, diagnosis, psychological adjustment ratings, ward behavior assessments, rehabilitation activity rankings, and family interest indices.

One ward was designated the experimental ward, and one the control. On the experimental ward the patients were formed into three comparable groups of 16 each. Each of these groups was assigned a particular psychiatric aide as group leader. The leader's function was to be with, familiarize himself with, and become most interested in his particular group of patients. The group leader was the one person (except for his co-leader who assumed these responsibilities on the leader's leave days) to accompany his patients to all activities. He was the hospital's main intermediary in dealing with the patient on the ward and the principal authority with respect to observations on his patients' clinical progress.

The aides on the control ward carried on their usual assignments. Although these aides were on duty at the same time daily, their work was rotated periodically so that they dealt with different patients on their ward from week to week and month to month (as had been the usual procedure before the research project began). All aides, both on the experimental and control wards, were carefully chosen on the bases of supervisor's ratings and interviews conducted by the Clinical Psychology Service. The major determining factors in selecting aides for both wards were the psychologist's assessments of the aides' capacity to work with others, their capacity to develop an interest in their patients, their potential for flexibility and improvisation, and their positive and optimistic attitudes toward the task of working with geriatric mental patients. It was understood that insofar as possible all aides would remain on the same shift for a period of one year, the duration of the study.

The clinical psychologist in the Geriatrics Service met regularly, both in scheduled weekly group discussions and in impromptu daily contacts, with ward personnel from both wards on day and evening shifts. Topics covered in these meetings included the aides' feelings about their patients and about their work; evaluation of progress or regression of patients; and administrative planning such as privileges, work assignments, leaves and passes, and discharge consideration for patients. In short, on both the experimental and control wards, the goal of the psychologist was to inculcate in the aides a therapeutic orientation and note of optimism based on interest and emotional involvement with patients. The psychologist attempted to deal directly and as quickly as possible with resistances as they occurred among the personnel.

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During the period of the study, about half the patients on each ward received an average of two of the newer stimulant and ataractic drugs for an average of one month with each drug. However, the dosages were so small and duration of treatment so short as compared with commonly accepted practices that the effect of drug therapy on the service was regarded as practically negligible. (For example, of the 30 patients who were discharged during the study, only four had received the newer drugs.)

Major indices for classifying and later assessing change in patient behavior were the Lorr Multidimensional Scale for Rating Psychiatric Patients (Lorr, 1953) and the Hospital Adjustment Scale (McReynolds & Ferguson, 1953). The Lorr Scale (MSRPP) consists of 62 brief, unlabeled graphic rating scales which provide, in relatively objective and quantitative form, a description of the observable behavior or readily inferrable traits and common symptoms of hospitalized mental patients. The first 40 items are obtained from interview observations of the patient and the last 22 from ward observations. Twelve factors have been derived from the scales, with a "normal" score for each factor, e.g., Paranoid Projection, Melancholy Agitation, Perceptual Distortion, Motor Disturbances, Conceptual Disorganization. Deviations from the normal score are considered "morbidity" scores.

The Hospital Adjustment Scale (HAS) consists of 90 statements about behavior typical of many psychiatric patients. The statements can easily be scored as "True," "Not True," or "Don't Apply" by psychiatric nurses and aides who have observed the patient. These items cluster into three groupings: communication and interpersonal relations, self-care and social responsibility, and work activities and recreation.

Seven clinical psychologists on the hospital staff interviewed and made Multidimensional Scale ratings on all patients on the Geriatrics Service at the beginning of the study. One year later the same psychologists again rated those research patients remaining on the service. Since the Hospital Adjustment Scale was felt to be more detailed than the MSRPP with respect to overt ward behavior, that section of the MSRPP dealing with ward behavior was excluded from evaluation. The HAS was obtained on all research patients prior to and upon completion of the year's project by clinical psychology trainees' interviews with the two aides who were most acquainted with each patient's ward behavior.

FINDINGS

Administrative Data

At the end of the year five of the original 98 research patients had died, and 17 had either been discharged from the hospital or were in process and subsequently discharged within a few months. There were no significant differences between the two wards in the discharge rate.

Although a total of 176 patients resided on the Geriatric Service during the experimental period, initial MSRPP and HAS evaluations were made on only the original 98 patients (the research patients); and final evaluations were made on only 64 of the 98 who were still on the Geriatric Service at the end of the study. Twelve patients who had been transferred to the medical-surgical wards or to other hospitals were unavailable for re-evaluation. Of the 78 non-research patients who had resided on the two wards at various times during the twelve-month experimental period, 13 (six from the experimental, seven from the control ward) were discharged or in the process of discharge at the end of the year. There were no significant differences between the numbers of discharges of research and non-research patients; nor were there significant differences between discharge rates of the experimental and the control wards.

A time comparison between the research period and the 14 months prior to the research, however, reveals a significantly greater discharge rate on the Geriatric Service during the experimental twelve-month period. During this period, 30 patients were discharged or in process of discharge compared with six during the preceding 14 months. (This difference is significant at the .002 probability level.)

Behavioral Indices

Lorr Scale morbidity or "psychopathological deviation" scores for those 64 patients rated at the close of the one year study revealed less behavior disorder on the experimental ward than on the control ward. As shown in Table 1, changes in favor of the experimental ward were significant at the .06 level. Those patients on the experimental ward who remained the entire year were initially more deviant than the

group as a whole, but showed improvement over the year; the control ward patients who remained were similar to the group as a whole initially, but showed some deterioration and a wider variability in their final ratings.

An examination of specific behavioral factors in the MSRPP, as shown in Table 2, reveals that the main improvement among the experimental ward patients was in the decrease of Motor Disturbances. In addition, the control ward patients showed significantly more impairment after the year's study period on two factors, Melancholy Agitation and Conceptual Disorganization. These three factors discriminated between the two wards in favor of the experimental ward.

An analysis of the HAS showed both wards with significantly higher ward behavior adjustment after the year's study. A comparison of the two wards shows that greater improvement was made by the patients on the experimental ward.

As shown in Table 2, experimental ward patients, but not control ward, had improved in the area of social responsibility. Communication and work activities improved comparably on both wards.

One of the most hopeful results of the project has been the continuation of its effects after the termination of the research phase. One year is a comparatively brief period in which to bring about significant changes in the hospital status of aged chronic mental patients. Even when many of these patients show sufficient improvement to warrant discharge planning, such pocedures are lengthy. Nevertheless, in 1957, the first year following the close of the study, 38 patients were discharged or placed on trial visit from these two wards, an increase of 27 per cent over the research year itself; and in 1958, 56 patients left the hospital from these two wards, a further substantial increase over the previous year.

DISCUSSION

Our data show favorable results among geriatric mental patients in response to a research treatment program. A number of variables should be considered in evaluating these results:

1. The assignment to the Geriatrics Service of a full-time therapeutic team consisting of a physician, a psychologist, and a social worker.

2. The selection of highly motivated nursing personnel stabilized with respect to shift and ward assignments. (It should be pointed out, however, that there was no increase in the actual number of nursing personnel assigned to the service.)

3. The use of ataractic and stimulant drug medication; which, while utilized to a very limited extent, might have contributed to the positive results.

4. The increased interest and involvement in the project of rehabilitation personnel.

However, none of these variables satisfactorily account for the more favorable ratings of patients on the experimental ward when compared with those on the control ward. The observed differences appear more likely to reflect the more intensive relationships between patients and nursing personnel on the experimental ward.

TABLE 1. MEANS AND STANDARD DEVIATIONS OF MORBIDITY SCORES[a] ON MODIFIED MSRPP FOR EXPERIMENTAL AND CONTROL WARDS BEFORE AND AFTER ONE-YEAR EXPERIMENTAL PERIOD.

Ward	N	Morbidity Scores			
		1955		1956	
		Mean	Sigma	Mean	Sigma
Experimental	28	35.1	16.8	30.0	16.8
Control	36	31.4	12.2	35.5	18.6

[a] The higher the "Morbility Score," the more an individual deviates from the "normal" individual's ratings (i.e., "sicker" patients have higher morbidity scores).
Analysis of covariance yields: F-ratio = 3.65; p = .06.

TABLE 2. SIGNIFICANT IMPROVEMENT AND IMPAIRMENT IN SCORES ON MSRPP AND HAS FACTORS, 1955 TO 1956.

Factor	Experimental Group	Control Group
Melancholy Agitation (MSRPP)	No Change	Impairment[a]
Motor Disturbances (MSRPP)	Improvement[a]	No Change
Conceptual Disorganization (MSRPP)	No Change	Impairment[b]
Communication (HAS)	Improvement[c]	Improvement[c]
Social Responsibility (HAS)	Improvement[c]	No Change
Work Activities (HAS)	Improvement[c]	Improvement[c]

[a] Differences between scores in 1955 and 1956 significant at the .05 level.
[b] Differences between scores in 1955 and 1956 significant at the .02 level.
[c] Differences between scores in 1955 and 1956 significant at the .01 level.

SUMMARY

A combined research and treatment program for the aged mentally ill has been described. In general, the findings indicate that when qualified personnel were selected, when their interest and involvement were consistently reinforced through discussion and support, and when their resistances were dealt with directly as they arose, increased positive effort was generated among those personnel. The ensuing positive effects even upon a group of extreme chronic and regressed mental patients was then demonstrable.

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SYMPTOM SYNDROMES AMONG AGED PSYCHIATRIC PATIENTS*

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Of growing concern in the field of mental illness is the population of older people. This concern has resulted from the increase in life expectancy and the large proportion of institutionalized mentally ill who are over 60 years of age. The present investigation was concerned with the patterns of symptoms found among aged psychiatric patients. Using the statistical procedure of inverse factor analysis, an attempt was made to identify and describe groups of patients with similar patterns of symptoms. By this method the investigators hoped to achieve an improvement in classification systems which is essential to improved diagnosis and treatment.

The confounding of physiological and psychological factors presents a major difficulty in evaluating the aged mental patient. In the usual care of the aged there is the implicit assumption that their condition is irreversible due to physical changes. Taking structural pathology for granted has resulted in minimizing concern with dynamics or functional etiology. However, there is an absence of convincing correlation between cerebral changes and behavioral disorders. For example, Matthews and Stevenson (1955) have presented some case studies which led them to believe that no one-to-one relationship exists between psychoses of old age and anatomic change in the brain. Sands and Rothschild (1952) have emphasized the need for some accurate knowledge of the personality as well as knowledge of the organic processes involved, and Wilson has suggested that the approach to pathology incorporates concepts of the individual and attitudes of society as well as the analysis of body tissue. He has stated the matter rather clearly: "The pathology of senility is found not only in the tissues of the body, but also in the concepts of the individual and in the attitude of society" (1955, p. 905). Roth (1955) estimated from his research that about one half of all admissions aged 60 and over are suffering from affective disturbances. Two rather extensive studies (Conwell, Kurth, & Murphy, 1955; Roth, 1955), which made rigorous diagnostic attempts to determine prognosis and appropriate treatment, found recovery from the functional or affective psychoses remarkably high. Perhaps the extension of many of the usual functional diagnostic categories and considerations to the aged patient would be more useful than has heretofore been thought. Rothschild (1956) has suggested groupings of older patients which would reveal the various forces operating in the illness. The implications for therapy of a group which is more dynamically oriented are only beginning to be realized.

The first steps in diagnoses rely on symptoms. However, the evaluation of the older patient is too often the result of speculation concerning etiology rather than the result of careful psychiatric evaluation. The use of rating scales is one way to quantify and objectify this process of description and classification—although at present no claims are made that the scales can substitute for other methods of diagnosis. In most studies involving rating scales, older patients have not been included and norms for the aged do not appear to exist. One exception is an investigation by Wittenborn, Bell, and Lesser (1951), who found that symptom patterns among older patients with organic involvement formed fewer discrete clusters than the symptoms presented by a younger functional group. The present study, however, uses inverse factor analysis, in which clusters of persons rather than cluster of tests are sought. The purpose is to isolate homogeneous groups of patients within the heterogeneous sample. On a population of outpatients, Tatom (1958) has demonstrated that an inverse factor analysis of ratings yielded interpretable groupings of patients. The same design is followed in this study.

METHOD

Subjects

The *S*s were 20 female psychiatric hospital patients ranging in age from 56 to 93 years with an average age of 70 years. Approximately

* This report is based on a M.S. thesis by the first author, supervised by the second. The authors wish to express their appreciation to Drs. Mark Risser and Millard Fisher of the State Hospital, Hollidaysburg, Pennsylvania, for their cooperation.

30 patients were interviewed and rated. This group represented the majority of patients who were willing or able to be interviewed and rated from a ward of over 100. For purposes of factor analyzing the data, the number was reduced to 20. The final group of patients used in the analysis was selected on the basis of diagnostic classification in an effort to have diagnostic groups represented in nearly equal numbers. Each patient's recorded diagnosis and matrix number are listed in Table A.[1] Three of the patients were diagnosed manic depressive, four were schizophrenic, five were arteriosclerotic, three had syphilitic involvement, and the remaining five had diagnoses involving senile changes.

Measure

The rating scale employed in this study to measure the symptoms was the Multidimensional Scale for Rating Psychiatric Patients (MSRPP) designed by Lorr (1953), which consists of 62 brief, unlabeled and randomized scales. The first 40 scales depend upon information and judgment gained from the interview, while the last 22 scales are based upon more objective ward observations. For example, symptoms having to do with relevant or irrelevant speech and with the presence or absence of bizarre postures are rated following the interview; symptoms dealing with eating and sleeping habits are rated in conference with ward personnel. The hospital form is presented in Table B. It is designed so that the traits and symptoms of the patient can be quantified to yield judgments which are little affected by the rater's own theoretical persuasion and which require minimum interpretation. Scale reliability is reported to be relatively high.

Each of the patients was interviewed for approximately an hour. Immediately following the interview the first 40 scales were checked from the information gained. An aide who knew the patient was used as informant for the ward observations.

Statistical Treatment

The ratings were analyzed by inverse factor analysis. Each of the 62 scales was dichotomized so that the rating became presence or absence of the symptom. From these ratings an index of correlation, the phi coefficient, was computed between each pair of patients. The resulting 20 x 20 matrix of correlations was analyzed by Thurstone's centroid method.

The factors were interpreted by examining the items from the 62 scales which correlated most highly with each factor. Uncorrected phi coefficients were used, since some of our other work indicates that the correction may destroy the mathematical properties of the matrix.

RESULTS

The correlation matrix of ratings on the MSRPP is shown in Table C. Factor analysis of the matrix resulted in seven factors as indicated in Table D. A series of rotations was made to obtain simple structure on as many of the factors as possible. The reference axes of factors I, II, III, and IV were sufficiently well defined to consider them as relatively independent factors, while the remaining factors appeared less meaningful because of low loadings and lack of independence. Table E shows the final rotated oblique factor loadings of the patients' ratings on the MSRPP.

The first four rotated factors were correlated with the patients' ratings on each item to give a total of 248 point biserial correlations as shown in Table F. The items selected to aid in interpreting and naming each of the factors consisted of those correlating .60 or higher with the factors. The sign of the correlation indicated which end of the scale was associated with a high loading on the factor. It should be noted that, although the extreme ends of each scale are used in describing the patient's particular rating, the rating may actually be nearer the tendency of the patient's behavior. Two patients may vary somewhat in degree of severity on a manifest symptom or item but score alike because of the dichotomy established for purposes of analysis. Since an inverse factor analysis has been made, the four factors to be described may conveniently be thought of as hypothetical persons.

In the following discussion of the syndromes, the interview notes lend considerable support to the rejection or confirmation of alternate hypotheses concerning the essential nature of the symptom cluster. The interpretations are tentative and need verification in similar studies before the factors can be considered reliable or stable. The sample of patients is not large, and

[1] Tables A-F have been deposited with the American Documentation Institute. Order Document No. 6034, remitting $1.25 for 35 mm microfilm or $1.25 for 6 by 8 in. photocopies. Order from ADI Auxiliary Publication Project, Photoduplication Service, Library of Congress, Wash. 25, D.C. Make checks payable to Chief, Photoduplication Service, Library of Congress.

does not purport to represent the total hospitalized female geriatric population. The names of the factors are merely suggested summaries of the characteristics suggested by the items.

Factor I. Apathetic Withdrawal. This factor accounted for 13 per cent of the variance. The eleven items which are most descriptive of Factor I are contained in Table 1. Factor I presents a rather clear picture of a loss of contact and lack of interaction with the surrounding environment. Autistic thinking is dominant. Much of the observed behavior might be classed as schizophrenic. Withdrawal, hypochondriasis, restricted or inappropriate speech, and some difficulty in relating to others are typical experiences of those with high loadings on this factor. Activity on the ward by these patients is less than average. There is also a tendency for the patients to express dissatisfaction and depression. Little effort is put forth by the patients to ameliorate these conditions.

Factor II. Intellectual Disturbance. This factor accounted for 15 per cent of the variance. The nine items correlating highest with Factor II are shown in Table 2. The most symptomatic items on this factor describe disorientation and a preoccupation with insistent thoughts which are difficult to halt or control. Although contact with others is not particularly limited, there is difficulty experienced in remembering names. The main disturbance here might be thought of as intellectual rather than affective. Flights into fantasy take the form of reminiscences that might be either former gratifications which the patient elaborates or thoughts of earlier unpleasant experiences. Otherwise, these patients seem to exercise a good deal of control and may appear less disturbed than most other hospitalized patients of this same age range. Hurried movements, along with other traits listed, suggest an interest in keeping up with and adjusting to the environment. The tendency is for these people to have an over-optimistic attitude in general.

Factor III. Verbal Compensation for Unpleasant Ideas or Conditions. Factor III, which accounted for 9 per cent of the variance, appears to involve a minimum of deterioration. The seven items most useful interpreting the traits of this hypothetical person are listed in Table 3. The most pathological item describes the patient as disturbed by hostile impulses. The other noticeable element in this factor is the coherent verbal behavior which serves the patient as a defensive measure. In one instance, these impulses were rationalized as self defense. One patient was able to explain to her own satisfaction, though not correctly, why she was in the hospital. Another patient admitted that she tries to think only of pleasant things. Adjustment to old age, institutionalization, and accompanying vague fears has taken the form of verbal compensation, with a conscious effort to channel attentions away from threatening ideas. The personality and intellect are fairly intact but with some affective disturbance and decreased efficiency. Emphasis on tidiness may be evidence of a reaction against impulses that are guilt provoking.

Factor IV. Hyperactivity. The last factor which was interpreted accounted for 10 per cent of variance of the matrix. The number of subjects and the small loadings indicated that not more than four factors should be interpreted. The items correlating with this factor, shown

TABLE 1. ITEMS WITH THE LARGEST CORRELATIONS WITH FACTOR I.

Item No.	Correlation	Description of Rating on Item
50	.90	Helpless
51	.86	Does no work
62	.78	Destructive
21	.75	Extreme body concern
53	.75	Slovenly and dirty
58	.72	Stays by herself
45	.67	Movements slowed
55	.65	Frequent resistance
52	.63	Does not answer
28	.63	Stereotyped speech
1	.61	Irrelevant speech

TABLE 2. ITEMS WITH THE LARGEST CORRELATIONS WITH FACTOR II.

Item No.	Correlation	Description of Rating on Item
43	.93	No profanity
47	.88	Rarely irritable
15	.83	Disoriented for people
45	.80	Movements hurried
18	.76	Preoccupied by insistent thoughts
22	.67	No hallucinatory sounds or voices
61	.67	No bullying
16	.63	No hostile impulses
27	.61	No hallucinatory visions

TABLE 3. ITEMS WITH THE LARGEST CORRELATIONS WITH FACTOR III.

Item No.	Correlation	Description of Rating on Item
13	.77	No specific morbid fears
53	.74	Neat and clean
11	.70	Coherent speech
28	.70	No stereotyped speech
57	.69	Many interests
16	.64	Disturbed by hostile impulses
54	.60	Sensible speech

in Table 4, describe an agitated and excited person. Two of three manics in the sample had high loadings on this factor. This factor should not be interpreted as the opposite of Factor I. Statistically, these two factors are relatively independent of one another. The patients high on this factor are also in poor contact with others, although they may appear to be more interested in their environment.

A comparison of the clustering of patients on each of the factors with the diagnostic categories of these patients reveals a definite lack of consistency in descriptive value of the standard psychiatric classifications in terms of behavioral and ideational symptoms as measured by the MSRPP. On this basis, it is suggested that researchers in the area of old age be especially cautious in utilizing groups or figures based on standard diagnostic labels or in assuming that patients of the same classification have similar psychological characteristics or descriptive homogeneity. Further investigation with techniques such as factor analysis may eventually establish stable factors or groupings which would be considerably more useful in the clinical setting when evaluating and caring for the aged.

TABLE 4. ITEMS WITH THE LARGEST CORRELATIONS WITH FACTOR IV.

Item No.	Correlation	Description of Rating on Item
20	.96	Shouts or yells
39	.83	Perplexity
34	.82	Elated
35	.78	Suicidal preoccupation
5	.78	Tense
19	.68	Frequent use of complaints
51	.68	Does no work
54	.63	Speech not sensible
7	.63	Fast reaction
6	.61	Conviction of sinfulness

SUMMARY

An inverse factor analysis was applied to the MSRPP ratings of 20 older patients. The extracted factors did not coincide with the diagnoses. The investigators consider the four factors isolated—apathetic withdrawal, intellectual disturbance, verbal compensation, and hyperactivity—to be tentative, but suggest that this procedure might prove helpful in developing more psychologically useful classifications of geriatric populations.

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THE PRESENTING PROBLEMS OF OLDER PATIENTS REFERRED TO A PSYCHIATRIC CLINIC*

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In recent years, professional workers dealing with medical and social services for older persons have repeatedly stated that mental illness affecting the aging and the aged has come to constitute one of the foremost problems in the area of socio-psychiatric disorders (Anderson, 1956; Bowman, 1957; International Association of Gerontology, 1955; Kaplan, 1956; Kutner, Fanshel, Togo, & Langner, 1956; Weiss, Gildea, Davis, & Mensh, 1958). Not only is the total number of older persons in the United States increasing at a rate entirely out of proportion to that of the population as a whole—today, almost one-third of the nation is over 50 years of age—but the age-specific rates for first admissions to mental hospitals have increased consistently in the last century only in these older age groups (Federal Security Agency, 1952; Goldhamer & Marshall, 1949; Gruenberg, 1950). The rates of hospitalization for mental illness are currently three times higher for persons 65 years old and older than for the general population (Felix & Kramer, 1953; Gruenberg, 1950). And there is good evidence that many of the non-institutionalized older persons still remaining in the community are suffering from some degree of psychiatric disorder (Downing & Gruenberg, 1957; Felix & Kramer, 1953; Gruenberg, 1953).

However, it is difficult to plan rational programs of prevention, treatment, or rehabilitation, for the nature and type of the psychiatric problems affecting non-hospitalized older persons have never been clearly established. The aim of this study was to investigate and analyze the presenting problems of older outpatients referred to a psychiatric clinic, and to relate these problems to pertinent demographic and clinical variables.

SUBJECTS

A preliminary survey of 603 consecutive "closed" case records of outpatients seen at the Malcolm Bliss Psychiatric Clinic during its initial two years of operation (from October 1954 to October 1956) revealed that approximately one-third of the patients were 45 years old or older. As a prior study of the total patient group had indicated that age was not, in itself, a factor in either the duration of treatment or in the voluntary or involuntary termination of treatment (Weiss & Schaie, 1958), the selection of "closed" cases provided certain advantages. Evaluation and treatment procedures had been terminated, so that each patient had equal opportunity to receive as complete a work-up as possible and to be at the same stage in treatment, and a final diagnostic formulation had been made for each case following review of the total record.

Following the exclusion of patients under 45 years of age, of mental defectives, of prisoners attending the clinic not by their own volition but because of court orders, and of patients for whom a definite final diagnosis could not be established, the subject population consisted of 112 white patients, 67 women and 45 men. These patients were predominantly native-born, predominantly Protestant or Roman Catholic, and almost all from the lower or lower-middle socioeconomic classes. Most of them were referred from the medical and surgical clinics, the wards, or the emergency room of St. Louis City Hospital, but some were referred from the inpatient services of Malcolm Bliss Mental Health Center, or by relatives, friends, or outside professional workers or agencies. Some were self-referred.

METHOD

After the complete case records had been thoroughly explored by members of the research

* Read at the 114th annual meeting of the American Psychiatric Association, San Francisco, California, May 12-16, 1958.

This paper is one of a series reporting a larger study of mental health problems of older persons in progress at the Malcolm Bliss Psychiatric Clinic, St. Louis, Missouri, supported by Research Grant M-1232 from the National Institute of Mental Health, U. S. Public Health Service.

† Dr. Schaie is now at the University of Nebraska, Lincoln, Nebraska.

team, it appeared that the presenting complaints of these patients were the most obvious, objective, quantifiable, and perhaps meaningful measures of their problems. As Whitehorn (1956) has pointed out, the patient comes to a medical facility for relief of his symptoms, and assumes that if these symptoms are alleviated or adequately modified, he may be able to function successfully within the community. Since 1926, when Adolf Meyer presented his plan for the reorientation of psychiatric diagnosis in terms of the patient's chief complaint, clinicians have emphasized the importance of presenting symptoms in making accurate diagnoses and prescribing appropriate treatment. Magraw and Dulit, for example, have recently stressed the need to consider the patient's problems *as they are seen by the patient*. ". . . What is bothering the patient does more than *point* to what the patient has. In a very real sense it *is* what he has. It is the diagnosis. It is the illness. . ." (1958, p. 335).

All complaints listed in the case records of these older patients were recorded verbatim on individual cards. These cards were sorted into different categories to see whether a meaningful classification system under which each and every complaint might be subsumed could be constructed. An original two-dimensional system emerged. These dimensions were called the "determinants" and the "referents" of each given complaint. The determinant identifies the dominant or major characteristic of the complaint (that is, its specific nature or type). The referent identifies any situational factor which the complainer relates in any way to the determinant (as the attributed cause or result of the determinant, or as coexisting with it). The seven determinants and five referents found relevant for classification are given below:

DETERMINANTS

1. *Affective:* expressing mood disturbance (as elation, depression, discouragement, irritability, etc.).
2. *Anxietal:* expressing anxiety consciously perceived and directly felt (as "nervousness," "uneasiness," "fearfulness," "worry," etc.) or indirectly perceived in terms of *thoughts* which are obsessive or phobic.
3. *Behavioral:* expressing disturbance manifested by overt action, or by changes in overt action patterns.
4. *Mentational:* expressing disturbance pertaining to intellectual functions, memory, orientation, or judgment.
5. *Reality Distortional:* expressing gross failure in evaluating external reality, as evidenced by hallucinations, delusions, or autistic or paranoid thinking.
6. *Welfare:* expressing only a desire for aid in changing a specific situation which is not primarily medical or psychiatric.
7. *Somatic:* expressing a disturbance which the *patient* typically considers to be physical in origin, and for which he would be likely to seek medical rather than psychological or psychotherapeutic help.

REFERENTS

a. *Physical Health:* referring to bodily health or illness.
b. *Mental Health:* referring to psychological health or disturbance.
c. *Economic:* referring to financial or occupational situations.
d. *Interpersonal:* referring to situations primarily in terms of relationships with other persons.
e. *Non-situational:* no related situation specified.

EXAMPLES

1a. "I am discouraged because I have headaches."
2b. "I worry about losing my mind."
3c. "I am not as good at work as I used to be."
4d. "At times people get me so mixed up I don't know what is going on."
5e. "I believe I have special powers."
6c. "I need a job."
7b. "I can't sleep because I am so nervous."

Thirty-five possible complaint categories were obtained by combining these determinants and referents. In the first example given, "I am discouraged because I have headaches," the determinant is of an affective nature (i.e., "I am discouraged"); "because I have headaches" indicates a physical health referent. With one exception, complaints were accepted at face value. Insomnia, for example, was classified as a somatic determinant regardless of the underlying anxiety which might be present; memory disturbance was classified as a mentational determinant regardless of any possible underlying depression. The one exception involved blatant delusional or paranoid thinking: "All my neighbors are trying to murder me" would be classified as reality distortional.

By the use of this system, each complaint was classified independently by a psychiatrist, a clinical psychologist, and a research psychologist-statistician. Except for a few ambiguous, poorly expressed, or poorly recorded complaints (which were discarded), agreement among judges was very high, and all other complaints could be sorted easily within the 35 categories.

RESULTS

The 112 patients presented a total of 447 initial complaints, or about four complaints per

patient. When the complaints were corrected for "repetition"—by using only one complaint of any given combination per patient, to avoid spurious loading caused by verbose patients who gave numerous complaints of the same character—the total number of complaints was 315, or about three different kinds of complaint per patient.

Sex Differences and the Behavior of Complaining. After correcting for the sex ratio differential, women were found to be responsible for a significantly larger proportion of all complaints (about five complaints per woman, as compared to about three complaints per man); and women were also responsible for a significantly larger proportion of all possible complaint combinations (about four kinds of complaint per woman, as compared to about two kinds of complaint per man). That is, women complained more about their problems, and also complained about a greater variety of problems, than did men.

Men and women also differed significantly in the patterning of their complaints. Women's complaints were significantly loaded with somatic and reality distortional determinants, and were most often not related to situational stresses. Men, on the other hand, tended to relate current psychiatric problems to economic or occupational stresses.

Sex Differences and Diagnosis. The final diagnoses for all patients fit into one of five gross diagnostic categories: organic brain disorder, psychotic affective reaction (including involutional), schizophrenic reaction, psychoneurotic reaction, or personality (character) disorder. Within these diagnostic categories, men were found to have a distribution which did not differ significantly from chance. Women, however, differed significantly from a chance distribution in the diagnostic categories of psychoneurotic reaction and personality disorder. Almost exactly one-fifth of the men (9 ± 2) fell into each diagnostic category, whereas almost one-third of the women were diagnosed as suffering from psychoneurotic reactions, and only two out of 67 from personality disorders.

Diagnosis and the Behavior of Complaining. Comparison of the frequency with which the various determinants and referents were given by patients in each diagnostic category revealed that the patterning of complaints differed significantly from an assumed random distribution. This deviation from a chance distribution was, however, the result of a unique patterning of only four of the twelve complaint categories, namely: anxietal, mentational, and reality distortional determinants, and economic referents. All other determinants and referents occurred in the diagnostic categories with a frequency which could be attributed to chance.

Analysis showed further that specific kinds of symptoms were consistently associated with specific diagnostic categories (see Table 1). Patients diagnosed as having psychoneurotic reactions had significantly more anxiety complaints than did any other diagnostic group, patients with organic brain disorders had more mentational complaints, patients with schizophrenic reactions had more reality disturbance complaints, and patients with personality disorders related their complaints to economic or occupational stresses more than did any other diagnostic group.

Age Differences and Diagnosis. Within the various age groups, the proportion of patients diagnosed as having organic brain disorders increased significantly with age (from 4 per cent in the 45 to 54 year old group to 48 per cent in the 65 year old and older group). Personality disorders, on the other hand, were found significantly more often in the 45 to 54 year old

TABLE 1. FREQUENCY OF DETERMINANTS AND REFERENTS OF PSYCHIATRIC COMPLAINTS IN EACH DIAGNOSTIC CATEGORY.

	Final Diagnosis				
	Organic Brain Disorder	Psychotic Affective Reaction	Schizophrenic Reaction	Psychoneurotic Reaction	Personality Disorder
Determinants:					
Affective	6	10	7	17	3
Anxietal[a]	4	13	7	25[b]	5
Behavioral	18	13	13	18	9
Mentational[a]	17[c]	7	7	5	1
Reality Distortional[a]	2	5	15[d]	2	1
Welfare	5	0	4	7	5
Somatic	13	13	8	23	6
Referents:					
Physical Health	10	6	3	11	2
Mental Health	2	3	2	2	2
Economic[a]	5	2	4	7	10[d]
Interpersonal	8	13	15	16	3
Non-situational	40	37	37	61	13

Note.—The numbers in this table have been corrected for complaint category repetition (see text).

[a] Difference in distribution within diagnostic categories significant at the .02 level.

[b] Difference of proportion significant at the .05 level.

[c] Difference of proportion significant at the .02 level.

[d] Difference of proportion significant at the .01 level.

group (14 per cent) than in the 65 year old and older group (no cases). There were no significant differences related to age in the other diagnostic categories.

Age and Sex Differences. There were no significant differences in the sex ratios (that is, in the proportionate numbers of men compared to women) within the various age groups of patients.

Age Differences and the Behavior of Complaining. Analysis of the frequency of complaints as related to age indicated a strong tendency for older patients to make fewer complaints. Older patients also showed a significant decrease in the number of kinds of complaints they made. That is, as age increased, patients complained about a smaller variety of problems and also complained less about these problems.

An analysis of the complaint determinants and referents failed to reveal any significant differences related to increasing age. Although the *quantity* of complaints was related to age, the *quality* of complaining was apparently independent of this variable. For example, older patients did not make significantly more complaints with mentational determinants, although mentational complaints did occur significantly more often with organic brain disorder, a diagnosis which was made significantly more often as the age of the patient increased. This suggests that older patients may complain less even about those problems which appear clinically to be most pertinent to diagnosis in their age group.

DISCUSSION

In delineating significant differences in the behavior of complaining of psychiatrically disordered older persons, this study appears to confirm the working hypothesis that the patient's complaints are, in themselves, effective measures of his problems. The behavior of complaining also appears to be amenable to investigation using standard research techniques, although certain inherent limitations are involved.

A major limitation of this study is that the recorded complaints of the patient are already second-hand. The recording psychiatrist who interviews the patient is, of necessity, an intervening variable. The physician's selective perception is unavoidable, no matter how objective and accurate he tries to be. Moreover, even in the most unstructured interview, the patient's selective perception about what to tell the doctor, and the interaction between patient and doctor, intervene and cause distortion in reporting.

One method of decreasing such distortion might be to give each patient equal opportunity to select from an extensive group of representative complaints those which he feels apply to him, and to identify the degree of applicability for each complaint he selects. The investigators have already constructed such a "Psychiatric Evaluation Index," which they are currently giving, utilizing the Q-Sort technique, to each new patient during his first visit to the clinic.

Another limitation of the present study is the selective sample of patients. Although our complaint categories do not appear to be unique to this subject group, further research investigating symptom formation in a variety of other populations is needed for validation. The present study provides a framework for such future research.

SUMMARY

Complete case records of all patients 45 years old and older referred to a psychiatric clinic during a two-year period were carefully studied in an attempt to discover descriptive variables pertinent to the aging process. The complaints which brought these patients to the clinic appeared to be objective measures of behavior which could be considered both quantifiable and meaningful. All complaints were categorized by means of an original system of classification which emerged when the complaints were studied independently by members of the research team. Using this descriptive classification system, the investigators found that valid analysis could be made of the interrelationships among such variables as the nature and frequency of the complaints, age, sex, and diagnosis.

In general, women complained more about their problems than men, and had a greater variety of symptoms which tended to center about somatic and reality disturbance problems. Men tended to relate current psychiatric problems to economic or occupational stresses.

Various kinds of symptoms were consistently associated with specific diagnostic categories. Age differences did not affect the kinds of complaints that patients made, although older patients generally complained less and had less variety to their complaints than did younger patients.

The study indicated that patients' complaints can be effective measures of their problems, and that empirical investigation of the behavior of complaining can be productive in evolving new theoretical concepts which may, in turn, be useful in planning treatment and rehabilitation procedures for psychiatrically disordered older patients.

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JOURNAL OF GERONTOLOGY

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VOLUME 14, SECTION C OCTOBER, 1959 NUMBER 4

ORGANIZATION SECTION

Program

Twelfth Annual Meeting of the Gerontological Society, Inc.

Hotel Statler Hilton, Detroit, Michigan

November 12, 13, 14, 1959

Program Chairmen

WILMA T. DONAHUE, *Program Chairman*

W. ANDREW, *Biological Sciences*
R. T. MONROE, *Clinical Medicine*
M. E. BUNCH, *Psychological and Social Sciences*
J. KAPLAN, *Social Welfare*
H. SHORE, *General Membership Division*

Local Arrangements Chairman

A. H. PRICE

Exhibits Chairman

L. GITMAN

Thursday, November 12

8:00-10:00	Registration—Oak Foyer
10:00-11:30	General Session—"Cross National Research and Training in Gerontology"—Ballroom
11:30- 1:30	Luncheon Intermission
1:30- 3:00	Papers, Five Concurrent Sessions. (See program for room assignments) (Biological Sciences and Clinical Medicine Sessions start at 2:00 p. m.)
3:00- 3:30	Coffee Break and Viewing Exhibits—Courtesy Michigan Society of Gerontology—Oak Foyer, Washington Corridor, and Parlor E
3:30- 5:00	Papers—Biological and Clinical Sections Joint Symposium—Psychological and Social Sciences, Social Welfare —"Approaches to the Meaningful Use of Time by Older Adults"
6:00- 6:45	Reception and Social Hour—Courtesy Parke Davis Company—Michigan and English Rooms
6:45- 9:00	Dinner, Addresses—Wayne Room

Friday, November 13

8:00- 9:00	Business Meetings of each of the Four Sections and General Member Division of the Society. (See program for room assignments)
9:00-10:30	General Session—"Beyond Today's Horizons in Research and Training in Gerontology"—Ballroom
10:30-11:30	Papers, Five Concurrent Sessions. (See program for room assignments)
11:30- 1:30	Luncheon Intermission
2:00- 5:00	Papers, Five Concurrent Sessions. (See program for room assignments)
7:45- 9:00	Public Meeting—Wayne Room—Sponsored by Metropolitan Detroit Committee on Aging

Saturday, November 14

9:00-11:30 Papers, Five Concurrent Sessions. (See program for room assignments)

12:00- 2:00 Conference Luncheon, Business Meeting, and Summary of 1959 Meeting—Michigan Room

TECHNICAL EXHIBITS—Oak Foyer and Washington Corridor

SCIENTIFIC EXHIBITS—Washington Corridor and Parlor E

All meetings and exhibits are on the Ballroom Floor

THURSDAY, NOVEMBER 12

8:00 a. m.-10:00 a. m.—Registration

Oak Foyer, Ballroom Floor

10:00 a. m.-11:30 a. m.

General Session
Symposium

Cross National Research and Training in Gerontology

Ballroom

Chairman: ERNEST W. BURGESS, Consultant, Industrial Relations Center, The University of Chicago.

FRIIS, HENNING, Director, The Danish National Institute of Social Research, Copenhagen, Denmark.

TREANTON, JEAN-RENÉ, l'Université de Paris, Institute des Sciences du Travail, Paris, France.

WELFORD, ALLEN T., Professor, Psychological Laboratory, Cambridge University, St. Johns College, Cambridge, England.

11:30 a. m.-1:30 p. m.

Luncheon Intermission

1:30 p. m.-5:00 p. m.

Papers, Five Concurrent Sessions

(Sessions for Biological Sciences and Clinical Medicine begin at 2:00 p. m.)

Biological Sciences

Bagley Room

2:00 p. m.-3:00 p. m.

Chairman: W. ANDREW, Department of Anatomy, Indiana University Medical Center, Indianapolis.

2:00 p. m.

ROCKSTEIN, M.: Insects as Experimental Animals in Gerontologicai Research.

2:15 p. m.

ANDREW, W., AND ANDREW, N. V.: Capacity for Division of Nuclei of Neurons in Autonomic Ganglia of the Adult Mammal.

2:30 p. m.

STRONG, L. C.: Effects of Genetic Constitution and Maternal Age on the Aging Process in Mice.

2:45 p. m.

TONNA, E. A.: Osteoclasts and the Aging Skeleton: A Cytochemical and Autoradiographic Study.

3:00 p. m.-3:30 p. m.

Coffee Break and Viewing of Exhibits

Oak Foyer, Washington Corridor, and Parlor E

3:30 p. m.-5:00 p. m.

Chairman: W. ANDREW, Department of Anatomy, Indiana University Medical Center, Indianapolis.

3:30 p. m.

KIRK, J. E.: Anticoagulation Activity of Acid Mucopolysaccharides of Human Arterial Tissue.

3:45 p. m.

ALTSCHUL, R., AND FEDOROFF, M. ELAINE: Unruliness of Experimental Cholesterol Arteriosclerosis.

4:00 p. m.

SMITH, J. G., AND LANSING, A. I.: Distribution of Solar Elastosis (Senile Elastosis) in the Skin.

4:25 p. m.

KLINGSBERG, J., CANCELLARO, L., AND BUTCHER, E. O.: Aging and Adaptation Capacity of Oral Mucous Membrane of the Hamster.

4:40 p. m.

BROWNSON, R. H.: Effect of X-Irradiation on the Perineuronal Satellite Cells in the Cortex of Aging Brains.

4:50 p. m.

MAKARI, J. G.: Antibodies to Amino Acids and an Antibody Inhibitor in Relation to Cancer and Aging.

Clinical Medicine

English Room

2:00 p. m.-3:00 p. m.

Chairman: L. GITMAN, Brooklyn Hebrew Home & Hospital for the Aged, Brooklyn.

2:00 p. m.

FREEMAN, J. T.: The First Fifty Years of *Geriatrics* (1909-1959).

2:15 p. m.

JACOBSON, S.: Hypothyroid State of the Older Individual.

2:35 p. m.

SMITH, J. G., JR., AND BRUNOT, F. R.: Hormonal Effects on the Aged Male Sebaceous Gland.

2:45 p. m.

FREEMAN, J. T.: Sexual Activities of the Normal Aging Individual.

2:50 p. m.

NEWMAN, G., AND NICHOLS, C. R.: Sexual Activities and Attitudes in Older People.

3:00 p. m.-3:30 p. m.

Coffee Break and Viewing of Exhibits

Oak Foyer, Washington Corridor, and Parlor E

3:30 p. m.-5:00 p. m.

Chairman: J. T. FREEMAN, Philadelphia.

3:30 p. m.

MORRISON, B. O.: Further Research in the Field of Analeptic Drugs in Therapy of the Aged.

3:45 p. m.

HARRIS, R., AND HOCHCHER, W.: Institutional Use of a New Psychic Energizer (Ro 5-0831).

4:00 p. m.

COHEN, L.: Clinical Plethysmography in the Preventive Management of Peripheral Vascular Disorders of the Aged.

4:15 p. m.

COHEN, T., LIPSCHUTZ, E., GITMAN, L., AND BOLKER, H.: An Evaluation of Liver Function Studies in the Aged.

4:30 p. m.

ORTEN, J. M.: Nutritional Requirements of the Older Person.

4:45 p. m.

SMITH, E. M., BRANDT, R. L., AND CURRIER, R. D.: Medical Care Needs and Rehabilitation Potential of Patients in Michigan's County Hospitals.

Psychological and Social Sciences

Ivory Room

1:30 p. m.-3:00 p. m.

Chairman: R. G. KUHLEN, Department of Psychology, Syracuse University, Syracuse.

1:30 p. m.

BYRD, E.: Anxiety Components in Older Persons.

1:45 p. m.

MELTZER, H.: Age Differences in Status and Happiness of Workers.

2:00 p. m.

BUSSE, E. W., AND EISDORFER, C.: Two Thousand Years of Married Life.

2:15 p. m.

KELLEY, E. L.: Personality Changes in the Middle Years.

2:30 p. m.

FEIGENBAUM, K., AND HAVIGHURST, R. J.: Principal Values of Leisure for Adults: A Factor Analysis.

2:45 p. m.

RIEGEL, K. F., AND RIEGEL, RUTH M.: On Changes in Social Attitudes and Interests During Old Age.

3:00 p. m.-3:30 p. m.

Coffee Break and Viewing of Exhibits

Oak Foyer, Washington Corridor, and Parlor E

3:30 p. m.-5:00 p. m.

Approaches to Meaningful Use of Time

Joint Symposium with the Section on Social Welfare and General Membership Division

Ballroom

Chairman: R. W. KLEEMEIER, Department of Psychology, Washington University, St. Louis.

HAVIGHURST, R. J.: Introduction.

COTTRELL, W. F.: Sources of Free Time in the Mature Years.

GORDON, MARGARET S.: Work and Patterns of Retirement.

MEYERSOHN, R.: Older Adults as Members of the Mass Audience.

KAPLAN, M.: Leisure Activities and the Older Adult.

Social Welfare

Michigan Room

1:30 p. m.-3:00 p. m.

Interdisciplinary Gerontological Rehabilitation

Chairman: B. GROSSMAN, Drexel Home, Chicago.

Symposium and Discussion: Interdisciplinary Aspects of Contemporary Gerontological Rehabilitation as Demonstrated in Current Research Demonstration Projects.

HACKLEY, J., Rehabilitation Education Service, Peoria.

MCCORD, VERA H., Rehabilitation Education Service, Seattle.

UNDERWOOD, B., Chronic Disease Program, U. S. Public Health Service, Washington.

3:00 p. m.-3:30 p. m.

Coffee Break and Viewing of Exhibits

Oak Foyer, Washington Corridor, and Parlor E

3:30 p. m.-5 p. m.

Approaches to Meaningful Use of Time

Joint Symposium with the Section on Psychological and Social Sciences and the General Membership Division.

Ballroom

General Membership Division

Parlor F

1:30 p. m.-3:00 p. m.

Toward a Definition of a Home for the Aged

Chairman: JACOB G. GOLD, Director, Orthodox Jewish Home for the Aged, Chicago.

At the National Conference of Nursing Homes and Homes for the Aged held in Washington in 1958 attempts were made to define a home for the aged. The U. S. Public Health Service has been studying this problem. At this session a distinguished panel of administrators and representatives of national church groups will present definitions and descriptions in an effort to arrive at clarification and understanding.

3:00 p. m.-3:30 p. m.

Coffee Break and Viewing of Exhibits

3:30 p. m.-5:00 p. m.

Approaches to Meaningful Use of Time

Joint Symposium with the Sections on Psychological and Social Sciences and Social Welfare.

Ballroom

6:00 p. m.-6:45 p. m.

Reception and Social Hour

English and Michigan Rooms

Gerontological Society, Michigan Society of Gerontology and Michigan State Commission on Aging.

6:45 p. m.-9:00 p. m.

Annual Dinner

Wayne Room

Presiding: WILMA DONAHUE, Chairman, Division of Gerontology, University of Michigan.

Detroit Greets the Society. A. HAZEN PRICE, Chairman, Geriatrics Committee, Michigan State Medical Society.

Michigan Extends a Welcome. THE HONORABLE G. MENNEN WILLIAMS, Governor of Michigan.

Role of the Society in the White House Conference on Aging. CLARK TIBBITTS, Special Staff on Aging, U.S. Department of Health, Education, and Welfare.

The Gerontological Year. LOUIS KUPLAN, President, Gerontological Society, Inc., and Executive Secretary, California Citizens Advisory Committee on Aging.

FRIDAY, NOVEMBER 13

8:00 a. m.-9:00 a. m.

Section Business Meetings

Biological Sciences—Bagley Room

Clinical Medicine—English Room

Psychological and Social Sciences—Ivory Room

Social Welfare—Michigan Room

General—Parlor F

9:00 a. m.-10:30 a. m.

General Session

Symposium

Beyond Today's Horizons in Research and Training in Gerontology

Ballroom

Chairman: HARDIN B. JONES, Associate Director, Institute of Human Development, University of California.

BORTZ, E. L., Chief, Medical Service, Lankanau Hospital, Philadelphia.

CLAGUE, E., Commissioner, Bureau Labor Statistics, U. S. Department of Labor.

ENDICOTT, K. M., Associate Director, National Institutes of Health, Public Health Service.

TIBBITTS, C., Special Staff on Aging, U. S. Department, Health, Education, and Welfare.

10:30 a. m.-11:30 a. m.

Papers, Five Concurrent Sessions

Biological Sciences

Bagley Room

Chairman: JAMES B. ROGERS, University of Louisville School of Dentistry, Louisville

10:30 a. m.

KAHN, R. L., KIM, S. H., AND CURTIS, A. C.: Effect of Age on Capacity to Localize Skin-Injected Protein.

10:45 a. m.

SOBEL, H.: Studies on Acceleration of Aging by X-Irradiation of Rats.

11:00 a. m.

BOHATIRCHUK, F. P.: Calcifications and Ossifications as Seen in Old Age.

11:15 a. m.

MCCLENDON, J. F., AND GERSHON-COHEN, J.: On the Production of Osteomalacia by Dietary Means.

Clinical Medicine

English Room

Chairman: S. GERTMAN, University of Miami School of Medicine.

10:30 a. m.

MAKARI, J. G.: Detection of Tumors in Man by the Skin Testing of Polysaccharide-Antibody Complexes.

10:45 a. m.

CRANIN, A. N., AND CRANIN, S. I.: Intramucosal Insert for Maxillary Denture Stabilization.

11:00 a. m.

PESZCZYNSKI, M.: A Hospital-Connected Sheltered Workshop for the Severely Disabled and the Aged.

11:15 a. m.

BAGINSKY, R. G.: Electromyographic Studies of Common Gait Patterns in the Geriatric Patient.

Psychological and Social Sciences

Ivory Room

Chairman: W. R. MILES, U. S. Navy Medical Research Laboratory, New London, Connecticut.

10:30 a. m.

BOTWINICK, J., AND KORNETSKY, C.: Age Differences in the Frequency of the GSR During a Conditioning Experiment.

10:45 a. m.

OBRIST, W. D., AND BUSSE, E. W.: The Senescent Electroencephalogram.

11:00 a. m.

COPPINGER, N. W., AND SAUCER, R. T.: Critical Flicker Frequency and Shortest Noticeable Dark Time as a Function of Behavioral Efficiency.

11:15 a. m.

EISDORFER, C.: Rigidity and Sensory Intactness in a Senescent Population.

Social Welfare

Michigan Room

10:30 a. m.

Gerontological Frontiers in Japan

Chairman: MARY K. GUINEY, United Community Service of Metropolitan Detroit.

BOWEN, GEORGENE: New Frontiers in Japan for Training in Gerontology.

11:20 a. m.

Discussion

General Membership Division

Parlor F

Adult Education and Preparation for Retirement

Chairman: C. E. ODELL, Director, Older and Retired Workers Department, United Auto Workers, Detroit.

At the 11th Annual Michigan Conference on Aging certain basic concepts in social gerontology were evolved by a special research seminar. These concepts will be explored by the panel discussion method as they relate to the planning, conduct, and evaluation of programs of retirement preparation education conducted under the joint sponsorship of several Michigan universities and the U. A. W. International Union.

ALDRIDGE, G.: Chairman, School of Social Work, Michigan State University, Lansing.

HUNTER, W. W., Research Associate, Division of Gerontology, University of Michigan, Ann Arbor.

PETERS, MILDRED, Professor of Education, Wayne State University, Detroit.

11:00 a. m.-2:00 p. m.

Luncheon Intermission

2:00 p. m.-5:00 p. m.

Papers, Four Concurrent Sessions

(No session for Biological Sciences)

(Psychological and Social Sciences session ends at 3:30 p. m.)

Clinical Medicine

English Room

Chairman: R. D. CURRIER, Ann Arbor.

2:00 p. m.

ALTSHULER, I. M., REPUCCI, L. C., MCKENZIE, L. L., WELLS, H. J., AND JENKINS, J. B.: Attitude of the Aged Toward Physical Handicaps.

2:20 p. m.

DOVENMUEHLE, R. H.: Physical Problems of Aging People.

2:45 p. m.

CUMMINS, J. F.: Physical Findings in the Ambulatory Octogenarian.

3:00 p. m.

GERTMAN, S.: Uses of a Geriatric Clinic.

3:25 p. m.

HARRIS, O. J., AND CUMMINS, J. F.: Establishing a Research-Oriented Clinic for Spanish-American War Veterans.

3:50 p. m.

PONS, J. A.: Dizziness: Its Relationships within the Aging Process.

4:15 p. m.

NEAL, M. W., AND SIMON, A.: Studies in Geriatric Mental Illness. A Preliminary Report.

4:30 p. m.

CURRIER, R. D.: Neurological Findings in County Hospital Patients.

Psychological and Social Sciences

Ivory Room

Chairman: W. W. MORRIS, Department of Medical Psychology, College of Medicine, State University of Iowa, Iowa City.

2:00 p. m.

SAUCER, R. T., AND COPPINGER, N. W.: A New Technique for the Study of Institutions.

1:45 p. m.

WEBBER, I. L., AND OSTERBIND, C. C.: Design of an Operational Research Project.

2:00 p. m.

WEISS, J. M. A.: Evaluating the Psychiatric Problems of Older Persons.

2:15 p. m.

JONES, E. S.: Role of Interests in Adjustments of Older People.

2:30 p. m.

GOLDSTEIN, S.: Health Status and Medical Costs of the Aged Population.

2:45 p. m.

POLNER, W.: Methodological Problems Concerning Comparability of Utilization Data by the Age of Hospitals.

Social Welfare

Michigan Room

(Five minutes' discussion after each paper)

Research and Training Implications of Varied Approaches

Chairman: MILDRED BARRY, Cleveland Welfare Federation.

2:00 p. m.

LENZER, A.: Some Implications of Sociological Theory for Gerontological Practice.

2:25 p. m.

SHEPPARD, H. L.: Political, Social, and Welfare Impact of Plant Shut-Down on Re-employment Experiences of Older Workers.

2:50 p. m.

BERMAN, M. G.: Group Counseling with Older Hospital Patients.

3:15 p. m.

BOEK, JEAN K., HARRIS, SARA R., BOEK, W., AND HARRIS, R.: Report of a Sample of 1200 Households in Albany County, New York, and Its Service Implications.

3:40 p. m.

WINTER, K. E.: An Investigation of the Nursing and Personal Care Needs of Older Patients in Nursing Facilities in Relation to Selected Characteristics of the Facilities.

4:05 p. m.

BEATTIE, W. M., JR.: The Aging Negro: Some Implications for Social Welfare Services.

4:30 p. m.

BOOTH, ESTELLE, MOORE, J. R., TINE, S., MCCONNELL, GRACE, AND DEUTSCHBERGER, S.: The Senior Citizens Center as a Therapeutic Community.

General Membership Division

Parlor F

2:00 p. m.-3:00 p. m.

State Voluntary Organizations

Chairman: H. J. FRIEDSAM, Chairman, Department of Sociology, North Texas State College, Denton.

Dr. Friedsam has conducted a survey of voluntary state organizations, their programs, scope of activities, role, and size of membership. He will describe his findings. Presentations will be made by:

I. L. WEBBER, Past President, Florida Council on Aging, St. Petersburg.

D. KENT, Executive Secretary, Connecticut Society of Gerontology, Storrs.

S. SPECTOR, Staff Director of the U. S. Senate Subcommittee on Problems of Aged and Aging, who will act as summarizer.

3:15 p. m.-4:45 p. m.

Housing the Aged

Chairman: C. FOLEY, Architect, Peoria, Illinois.

A summary of housing for the elderly with particular emphasis on Scandinavian housing will be presented and color slides and photographs will be shown.

7:45 p. m.-9:00 p. m.

Public Meeting

Sponsored by The Detroit Metropolitan Committee on Aging

Ballroom

Program to be Announced

SATURDAY, NOVEMBER 14, 1959

9:00 a. m.-11:30 a. m.

Papers, Four Concurrent Sessions

(No session for Clinical Medicine)

Biological Sciences

Bagley Room

Chairman: M. ROCKSTEIN, Associate Professor of Physiology, New York University, New York.

9:00 a. m.

SINEX, M. F.: Possible Mechanisms for Degenerative Changes in Protein Molecules Studied in Collagen and Elastin.

9:15 a. m.

HOFFMAN, J., KLEIN, ALICE, AND POST, J.: Aging and Hepatic Repair After Injury.

9:30 a. m.

MCALEAR, J. H.: Cell Structure Theory and the Phenomenon of Aging.

9:45 a. m.

STREHLER, B. L.: On the Mechanism of Aging of *Drosophila Melanogaster*.

10:00 a. m.

BARROWS, C. H., FALZONE, J. A., JR., AND SHOCK, N. W.: Age Differences in the Succinoxidase Activity of Homogenates and Mitochondria Isolated from the Livers and Kidneys of Rats.

10:15 a. m.

ROGERS, J. B., JOHNSON, W. L., AND RIDDLE, J.: Effect of Aging on the Growth of the Molar Teeth of Guinea Pigs.

10:30 a. m.

MIROFF, G. REITER, J. H., AND CORNATZER, W. E.: Phospholipid Metabolism of Liver and Brain Tissue of Inbred Strains of Mice with Increasing Age.

10:45 a. m.

HRACHOVEC, J. P., LEBLANC, M., AND ROCKSTEIN, M.: Changes in the Ratio of Free Cholesterol to Lipid Phosphorus in the Liver and Muscle of Senescent Rats.

11:00 a. m.

KAO, K-Y. T., HOPPER, J., AND MCGAVACK, T. H.: Influence of Age and Sex upon the Lipids of the Skin and Tendons of Rats.

11:15 a. m.

CORDREY, L. J.: Effect of Aging and Castration on Absorption of Strontium[85] in the Experimental Animal.

Psychological and Social Sciences

Ivory Room

9:00 a. m.-10:00 a. m.

Chairman: W. A. OWENS, Department of Psychology, Iowa State College, Ames.

9:00 a. m.

DIBNER, A. S., AND CUMMINS, J. F.: Intellectual Functioning of Fifty Spanish-American War Veterans.

9:15 a. m.

NICHOLS, MARGARET R., AND CUMMINS, J. F.: A Study of Eighty-five Spanish-American War Veterans and Their Lifelong Environmental Adaptation as Related to Their Current Adjustment to the Aging Process.

9:30 a. m.

BRITTON, J. H.: Expectations for Older Persons by Residents of a Rural Community: Solution of Personal Problems and Use of Sources of Help.

9:45 a. m.

HARLAN, W. H.: Characteristics of Retired Migrants to St. Petersburg, Florida, 1940-1954.

10:30 a. m.-11:30 a. m.

Chairman: G. J. ALDRIDGE, School of Social Work, Michigan State University, East Lansing, Michigan.

10:30 a. m.

FALEK, A., KALLMANN, F. J., AND JARVIK, LISSY F.: Longevity and Intellectual Variation in a Senescent Twin Population.

10:45 a. m.

SOAR, R. S., BOOTH, F. ESTELLE, AND TINE, S.: Critical Differences Between Vocationally Well-Adjusted, Rehabilitated, and Non-rehabilitable Older Men.

11:00 a. m.

PITTMAN, D. J.: Differences in Patterns of Drinking Among Individuals over 60.

11:15 a. m.

JEFFERS, F. C., AND NICHOLS, C. R.: Relationship of Activities and Attitudes to Physical Well-Being in Older People.

Social Welfare

Michigan Room

9:00 a. m.-10:00 a. m.

Social Aspects of Housing

Chairman: L. CANTOR, Beth Sholom Home of Virginia, Richmond.

9:00 a. m.

VIVRETT, W. K.: Dimensions of the Community of the Older Individual.

9:25 a. m.

KAPLAN, B., AND HAMMOND, W.: Public Housing for the Elderly in Chicago.

9:50 a. m.

Discussion

10:00 a. m.-11:30 a. m.

Social and Health Relationships in Institutions

Chairman: L. CANTOR, Beth Sholom Home of Virginia, Richmond.

10:00 a. m.

GOLDMANN, F.: Residents of Homes for the Aged: A Profile.

10:30 a. m.

LISSITZ, S.: A Study in the Motivation and Interrelationships of Patient and Staff.

11:00 a. m.

Discussant: R. MORRIS, Brandeis University, Waltham.

11:20 a. m.

Discussion

General Membership Division

Parlor F

9:00 a. m.-11:30 a. m.

Programs for the Aged, Multiple Approaches

Chairman: EILEEN E. LESTER, Medical Social Consultant, Health of the Aged, Chronic Disease Program, Division of Special Health Services, U. S. Department of Health, Education, and Welfare, Washington, D. C.

LEEDS, M.: Experience of a Volunteer-staffed State Commission on Aging.

TINE, S.: Developing Community Responsibility for Problems of the Aging, Nashville Senior Citizens Center.

LENZER, A.: Specialists and Citizens: Some Dilemmas in the Planning of Programs for the Aging.

SALAMONE, A.: Senior Citizens and Golden Age Clubs: What Kind of a National Organization?

WILSON, P. A.: A Review of Progress in Cleveland with Programs for the Aging.

12:00 noon-2:00 p. m.

Conference Luncheon, Business Meeting of the Gerontological Society, Inc., and Summary of 1959 Meeting

Michigan Room

Presiding: LOUIS KUPLAN.

Impressions of the 1959 Annual Meeting: ROBERT J. HAVIGHURST.

Adjournment.

Abstracts

All abstracts are edited by the respective Section Program Chairmen.

SECTION ON BIOLOGICAL SCIENCES

Abstracts edited by Warren Andrew, M.D., Ph.D.

Unruliness of Experimental Cholesterol Arteriosclerosis.

RUDOLF ALTSCHUL AND M. ELAINE FEDOROFF, *University of Saskatchewan, Saskatchewan, Canada.*

In 1950 Altschul reported that prairie gophers (synonym: ground squirrels; Cytellus or *Arctomys Richardsonii, Sabine*) which are herbivorous rodents, did not develop arteriosclerosis if fed milk and egg yolk for 7 months. At that time levels of serum cholesterol were not determined. In a recent experiment we found that in normal gophers fed calf meal pellets, the serum cholestrol showed an average of 285 mg.%. Twenty-two animals were fed *ad lib.* either calf meal pellets containing 5.4% cholesterol or such pellets plus milk and egg yolk cake. Five of these animals were killed after 2 months, 5 after 3 months, 4 after 4 months, 3 after 5 months, 3 after 8 months, and 2 after 10 months. At the time of death, the serum cholesterol ranged from 394 mg.% to 4087 mg.% (average 1365 mg.%) without correlation between duration of cholesterol intake and serum cholesterol levels.

Microscopic examination revealed increased liver fat or fatty livers and moderate liver cirrhosis in many of the 22 animals. Nephritis was frequent. However, vascular changes were found in only two cases. In one animal, which had a serum cholesterol of 1145 mg.%, there was a single lesion consisting of a few foam cells in the aortic lining, while in the other animal, which had a serum cholesterol of 962 mg.%, there was one slightly larger focus in the aorta and a distinctly atheromatous artery of small size in the myocardium.

It should be pointed out that the serum cholesterol of normal prairie gophers is higher than that of man or other species so far examined. Whether this is the reason for the resistance to arteriosclerosis in spite of production of hypercholesterolemia remains to be established.

Capacity for Division of Nuclei of Neurons in Autonomic Ganglia of the Adult Mammal.

WARREN ANDREW AND NANCY V. ANDREW, *Department of Anatomy, Indiana University Medical Center, Indianapolis.**

The autonomic plexus about the prostate gland and seminal vesicles offers especially favorable material for study of binucleate and multinucleate nerve cells. Ganglia from this region in seven monkeys, of the species *Macaca phillipensis*, have been studied. Evidences of a dual or bilobed character of individual nuclei are seen. Clear-cut figures of direct nuclear division (amitosis) have been identified. Apparently nuclear division is a continuing process in nerve cells in these ganglia even in the adult animal. The question as to whether nuclei of binucleate and multinucleate cells differ functionally from those of uninucleate cells is discussed and some considerations of the possibility of cytoplasmic division are given.

* Aided by a grant from the Josiah Macy, Jr. Foundation.

Age Differences in the Succinoxidase Activity of Homogenates and Mitochondria Isolated from the Livers and Kidneys of Rats.

CHARLES H. BARROWS, JR., JOSEPH A. FALZONE, JR., AND NATHAN W. SHOCK, *Gerontology Branch, National Heart Institute, National Institutes of Health, PHS, D.H.E.&W., Bethesda, and the Baltimore City Hospitals, Baltimore.*

Previous studies have demonstrated that the reduction with age in succinoxidase activity of kidneys (but not of livers) of old rats was greater than the decrement in the concentration of DNA. Since the succinoxidase activity has been associated with mitochondria, these data indicate that either the succinoxidase activity of mitochondria decreases with age or there are fewer mitochondria per unit of DNA and, presumably, per kidney cell in old rats. In order to test which of these possibilities is more likely, the activity of succinoxidase of homogenates and mitochondria isolated from livers and kidneys of 10 male and 10 female young (12-14 months) and a like number of old (24-27 months) rats was determined. The succinate stimulated oxidative phosphorylation of the homogenates was also measured. No age changes were found in liver tissues. Although the concentration of DNA was unchanged, the activity of succinoxidase and the rate of oxidative phosphorylation decreased significantly ($P = .01$) in homogenates prepared from the kidney of the old rats. However, no age-dependent decrement in the succinoxidase activity based on the protein nitrogen content of isolated mitochondria was observed. These data imply that mitochondria are lost from kidney cells during aging.

Calcifications and Ossifications as Seen in Old Age.

F. P. BOHATIRCHUK, *Department of Anatomy, University of Ottawa, Ottawa, Canada.*

The presence of excessive calcium in biological tissues is not a prerogative of the old; it may be encountered in any age. In some cases the excessive calcium does not acquire a structural form, and such an accumulation of formless calcium is called calcification. In other cases the excessive calcium converts an affected tissue into true bone, and such a metaplasia is called ossification.

Apparently both processes may develop due to the varied etiology, either common for the majority of people or individuals. Ossifications are more or less typical of normal (physiological) old age; calcifications

are always atypical and individual, e.g., those resulting from trauma or disease.

It is easy to differentiate morphologically between calcifications and ossifications making use of methods which investigate the tissue in question with its calcium *in situ*, without previous decalcification. Microradiography and stain historadiography used in this work are among these methods. In some cases such a differentiation is possible even in macroradiographs.

Three typical aging ossifications will be discussed in this paper: 1) ossification of rib cartilages; 2) ossification of tendon; 3) ossification on margins of joint surfaces (lipping).

It will be shown in microradiographs and colored specimens that the newly developed bone seems to be an exact continuation of the main bone. It will also be shown that the tendon bone develops from the tendon tissue proper and, therefore, is not a *corpus alienum* to the tendon.

The possibility of reversibility of ossification will also be discussed.

Effect of X-irradiation on the Perineuronal Satellite Cells in the Cortex of Aging Brains.*

ROBERT H. BROWNSON, *Department of Anatomy, Medical College of Virginia, Richmond.*

Information pertaining to the cytological effects of ionizing irradiation of the central nervous system has begun to indicate a certain selective sensitivity of the interstitial cell system.

The design of the experiment was to permit determination of the effects of x-irradiation on the perineuronal glial satellite cells in the cortex of the guinea pig brain. Forty male guinea pigs were utilized in the study, representing in months the following grouping: 1, 6, 9, 15, 28, and 62. The head of each experimental animal was exposed to x-irradiation delivered by a 1000 kv. potential x-ray unit at 3 ma., through a 2 mm. aluminum filter placed 45 cm. from the animal's head. The total dosage was recorded by means of a Victoreen chamber R-meter, while the unit was delivering at 258 roentgens per minute. The remainder of the animal's body was protected in a box lined by lead bricks. Each exposed animal received a total of 1600r to the head in two single doses, 800r to each side of the head. Control and experimental animals were sacrificed by perfusion fixation of formalin-saline-acacia 32 days following irradiation.

Under the conditions set forth in this experiment, it was noted that 32 days following total head exposure to 1600r the perineuronal glial satellite elements demonstrated negative to suppressed quantitative and qualitative activity.

* Supported by a Public Health Grant B-1289, National Institutes of Health.

Effect of Aging and Castration on Absorption of Strontium^{85} in the Experimental Animal.

L. J. CORDREY, *Tampa.*

Mice utilized as experimental animals were litter mates and were maintained under uniform conditions. Two techniques were investigated: 1) The effect of castration on C_a, P, and matrix content of normal mouse bone; and 2) the effect of both age and castration on Sr^{85} deposition and clearance in the mouse.

To evaluate the effect of castration on retention of Sr^{85} animals 4½ months old were utilized. Castrates and their controls were subdivided into subgroups with Sr^{85} injected 2 weeks following castration in the first subgroup, 4 weeks in the second subgroup, and 8 weeks in the third subgroup. No observable difference in Sr^{85} retention was noted in the first subgroup, but there was a definite increase in retention in the second and third subgroups.

To evaluate effect of age on retention of Sr^{85} in bone mice 2.5 months and mice older than 4.5 months were injected with Sr^{85}. It was conclusively demonstrated that age plays a significant part in deposition of Sr^{85} in bone and that the older the animal the less the retention.

In normal animals decreased retention of Sr^{85} of about 30% was noted between the 5- and 5.5-month-old group and an additional decreased retention of 20% was noted in the 6-month group. An increase of 30% retention was noted in castrates, demonstrating a change in bone metabolism present in addition to the change noted in aging alone.

Aging and Hepatic Repair after Injury.

JOSEPH HOFFMAN, ALICE KLEIN, AND JOSEPH POST, *Research Service, Third (New York University) Medical Division, Goldwater Memorial Hospital, Welfare Island.*

Healing of the livers of white male Wistar rats of different ages has been studied after acute hepatic necrosis, induced by a standardized technique, employing carbon tetrachloride as the hepatotoxin. Animals of 3, 8, 16, 24, 68, and 104 weeks of age have been observed at intervals of 48, 72, and 120 hours after administration of carbon tetrachloride. In addition to the histological studies, the nucleic acid contents (DNA and RNA) of the livers have been investigated.

The results show that histological healing is most rapid in growing rats and slower after maturity (24 weeks) has been reached. It is most delayed in aged animals (104 weeks). In addition, the liver undergoes changes in its DNA and RNA contents with advancing age. The data show that following injury the synthesis of nucleic acids is greatest in growing animals and declines after maturity.

While these experiments do not offer any basic explanation for the results obtained, on the basis of published studies from this laboratory, it is noteworthy that the healing pattern of 3-week-old rats resembles those of older (8 weeks) rats receiving growth hormone (Arch. Path., *64:* 278, 1957). On the other hand, the healing patterns of aged rats resemble those of 8-week-old rats receiving cortisone (Arch. Path., *60:* 10, 1955).

It is possible that as part of the complex phenomena involved in aging and its effect upon hepatic regeneration, there is a changing balance of these two hormonal influences to account in part for the striking differences observed in growing, mature, and aged rats.

Changes in the Ratio of Free Cholesterol to Lipid Phosphorus in the Liver and in the Muscle of Senescent Rats.*

JOSEPH P. HRACHOVEC. MICHÈLE LEBLANC, AND MORRIS ROCKSTEIN, *New York University-Bellevue Medical Center, New York, and Faculty of Medicine, Paris.*

It has been observed that the ratio of free cholesterol to lipid phosphorus in blood plasma increases during aging. Furthermore, this ratio in blood plasma is significantly elevated in human atherosclerosis and in coronary heart disease at all ages. This research was undertaken in order to investigate the changes of this ratio during aging in some organs or tissues which may be involved in lipid metabolism.

Lipid phosphorus and free cholesterol were determined in extracted lipids of the liver and of the skeletal muscle of Sprague-Dawley rats for three different age groups (6 to 12, 15 to 22, and 25 to 32 months). The method of Kumagawa was used for lipid extraction by boiling ethanol, followed by reextraction with anhydrous benzene.

The lipid phosphorus content, which amounts to 130-140 mg. per 100 Gm. of fresh liver and to about 45 mg. per 100 Gm. of fresh muscle in young adult rats (6-12 mo.), shows a decrease of about 10 to 15% in senescent rats (25-32 mo.) in both tissues, with intermediate values in old animals (15-22 mo.); the free cholesterol content, which amounts to about 200 mg. per 100 Gm. of fresh liver and to about 60 mg. per 100 Gm. of fresh muscle in young adult rats (6-12 mo). shows an increase of about 20 to 30% in senescent rats (25-32 mo.) in both tissues, with intermediate values in old animals (15-22 mo.) Consequently, the ratio of free cholesterol to lipid phosphorus increases gradually during aging in both tissues.

There is some indication from limited data that a similar trend takes place in kidney and in heart muscle of senile Sprague-Dawley rats. Data will also be presented for similar studies in C.F.N. (specific pathogen-free) white rats, currently in progress.

* This study was supported in part by a grant from the National Heart Institute of the U.S.P.H.S.

Effect of Age on Capacity to Localize Skin-injected Protein.

REUBEN L. KAHN, SUN HYOO KIM, AND ARTHUR C. CURTIS, *Department of Dermatology, University of Michigan Medical Center, Ann Arbor.**

The capacity of infant and adult rabbits to localize skin-injected organisms or proteins, presumably to prevent their spread, varies widely. Kahn reported (*Tissue Immunity,* Charles C Thomas, Pp. 417-443. 1936) that the injection of a suspension of virulent hemolytic staphylococci into the skin of adult rabbits led to local inflammation, to the absence of the organisms in the blood stream, and to apparently no ill effect, indicating localization of the organisms in injected area. One-tenth of the same suspension injected into the skin of 12-day-old rabbits, led to no local inflammation, to the presence of the organisms in the blood stream, and to the death of the animals, indicating the spread of the organisms from injected areas. Similarly, when proteins were injected into the skin, they were localized in adult rabbits, but not in infant rabbits.

The localization method used in this preliminary study was first described by Kahn (*Science, 79:* 172, 1934). The protein used for injection was horse serum diphtheria antitoxin (AT). When a given number of AT units are injected into a tissue, if localized, they will not be able to neutralize a lethal dose of specific toxin injected elsewhere in the animal; if not localized, the units will escape, reach the toxin, and neutralize it. Normal rabbits (35) of three age groups were injected subcutaneously under the same conditions with 15 units AT and, simultaneously, with 50 MLD toxin in another area. It was found that localization of the AT and death occurred: in 1 of 11 rabbits (9%) 3-4 weeks old (less than 3 lbs.); in 12 of 16 rabbits (75%) 8-10 weeks old (5-6 lbs.); and in 7 of 8 rabbits (88%) over 6 months old (7-8 lbs.), indicating marked increase in localizing capacity with the aging process. Since the same capacity is manifested also in preventing the spread of injected bacteria, it would seem that the aging of rabbits increases their natural immunity insofar as skin-localization is concerned.

* Supported by AEC Contract AT (11-1)-70, University of Michigan, Project 13.

Influence of Age and Sex upon the Lipids of the Skin and Tendon of Rats.

KUNG-LING TANG KAO, JOY HOPPER, AND THOMAS H. MCGAVACK, *Geriatrics Research Labs., Veterans Administration Center, Martinsburg, West Virginia, and Dept. of Medicine, George Washington University School of Medicine, Washington, D. C.*

Interest in the role of serum and tissue lipids in aging and in atherosclerosis has led to this study of lipids in the connective tissue of male and female rats 4-5 wk. and 7 mo. of age. Skin and tendon were each extracted successively by mixtures in proportions ( ) and with frequencies [ ] as follows: Acetone-alcohol (1:1) - [3]; ether-alcohol (3:1) - [2]; chloroform-methanol (2:1) - [1]. Data were derived from analyses upon the combined extracts.

In the skin of male rats at 4 wk. and 7 mo. of age, respectively, the total cholesterol decreased from 3.95 to 2.38 mg./100 Gm. of wet tissue; the ester cholesterol increased from 44% to 68%; the phospholipids decreased from 10 to 4 mg./100 Gm. of wet tissue; and there was no significant change in triglycerides. Corresponding changes in figures for the female were from 3.38 to 2.11 mg./100 Gm. of wet tissue; 39% to 56%; 10 to 4 mg./100 Gm. of wet tissue and 36 to 125 mg./100 Gm. of wet tissue.

In the tendon of the male rats, between 4 wk. and 7 mo. of age, the amount of total cholesterol decreased from 4.40 to 0.65 mg./100 Gm. of wet tissue; the ester cholesterol increased from 1% to 20%; the phospholipids decreased from 13 to 2.6 mg./100 Gm. of wet tissue and the triglycerides decreased from 31 to 9 mg./100 Gm. of wet tissue. Corresponding variations in figures for the female were, respectively, from 1.88 to 0.89 mg./100 Gm. of wet tissue; from 3.5% to 12.5%; from 7.14 to 2.06 mg./100 Gm. of wet tissue and from 45 to 12 mg./100 Gm. of wet tissue.

Studies similar to the above are now being obtained on animals 2 and 2½ yr. of age and will be included in the final data.

Anticoagulant Activity of Acid Mucopolysaccharides of Human Arterial Tissue.

J. E. KIRK, *Division of Gerontology, Washington University School of Medicine, St. Louis.*

Acid mucopolysaccharide material was extracted from the intima-media layers of 27 samples of the thoracic aorta by the procedure of Dyrbye and Kirk (*J. Gerontol., 12:* 20, 1957). The age of the subjects from whom

the samples were obtained ranged from 3 to 76 years. The average percentage composition of the isolated material was : SO_3, 12.5; hexosamine, 24.2; and uronic acid, 33.5. Eighty % of the hexosamine was galactosamine and 20% glucosamine. No significant change with age in the sulfate content of the samples was found. Analysis of electrophoretically separated fractions failed to reveal the presence of alpha-heparin in the material.

The anticoagulant activity of the mucopolysaccharide samples was measured by the procedure of Freeman, Engelberg, and Dudley (*Am. J. Clin. Path., 24:* 599, 1954). For comparative purposes a coagulation time test with heparin sodium, U.S.P., was run with each set of experiments. The arterial mucopolysaccharide material was found to possess a definite, but low anticoagulant activity which, when compared on a weight by weight basis, was less than 1% of that exhibited by heparin sodium. The anticoagulant activity of samples from children was moderately higher than the activity recorded for samples from adults.

Aging and Adaptation Capacity of Oral Mucous Membrane of the Hamster*

J. KLINGSBERG,† L. CANCELLARO, AND E. O. BUTCHER, *Department of Anatomy, New York University College of Dentistry, New York.*

This study was intended to investigate the effects of aging on the adaptation capacity of the oral mucous membrane of Syrian hamsters. The environment of the mucous membrane of 45 animals ranging in age from one month to two years was altered by two methods which resulted in the tissues being placed in direct contact with the atmosphere. The first method involved the extrusion of the cheek pouch through the skin of the neck and maintaining it in this position. This procedure placed the mucous membrane surface of the pouch in direct contact with the new environment. The second method involved exposing the labial gingiva of the mandibular incisors to the atmosphere, by surgically removing a portion of the lower lip.

The pouches were examined histologically after 17 days of exposure and the gingiva after 6 weeks. The stratum corneum of the control pouches, of 1-month, 6-month, and 2-year-old animals measured 7-10μ in thickness. The corneum of the experimental pouches of the 1-month and 6-month-old animals were found to have undergone a threefold increase, measuring 30μ. Examinations of the experimental pouch of the 2-year-old hamsters revealed a twofold increase measuring 15-20μ. In the same manner, measurements were made of the control and experimental gingiva. The results indicated an increase in keratinization in the 1-month and 6-month-old animals which substantially exceeded the increase found in the 2-year-old animals.

* Supported by grant from the National Institute of Health No. D366.

† Special postdoctoral Fellow.

Cell Structure Theory and the Phenomenon of Aging.

J. H. MCALEAR, *Division of Laboratories and Research, New York State Department of Health, Albany.*

Phylogenetic evidence, obtained by comparative ultrastructure of primitive cell types, has prompted the formation of a cell structure theory which accounts for the origin of the endomembranes and organelles of the cell from the plasma membrane. The Metazoa and the phenomenon of aging associated with them are discussed in terms of more fundamental properties of their component cellular units, especially the non-dividing neurosecretory cells which seem to play a dominant role in general endocrine tonus. An attempt will be made to estimate the applicability of cell ultrastructural studies and cell structure theory to the understanding of the general effects and possible control of the aging process.

On the Production of Osteomalacia by Dietary Means.

J. F. MCCLENDON, AND J. GERSHON-COHEN, *Departments of Radiology and Experimental Biochemistry, Albert Einstein Medical Center, Northern Division, York & Tabor Roads, Philadelphia.*

There is some confusion in the literature about osteomalacia as shown by the fact that osteoporosis and osteomalacia are used interchangeably, sometimes even in the same report. We have found that low phosphate diets produces osteomalacia in the rat. Perhaps the reason this has not been done before is because rats on low phosphorus diets are hard to maintain into adult life. We have spent several years testing diets that would produce osteomalacia on low phosphorus diets without resulting in early death of the animal. Instead of using the microscope to determine the amount of decalcification, we resorted to chemical analysis, using the ratio of ash to protein. In the normal animal this ratio was 2, but in osteomalacia it was 1.0 to 1.2. Our previous studies have shown that in osteoporosis this ratio was normal. We also found that animals with osteomalacia exhibited painful reactions when handled whereas these reactions were not present in animals with osteoporosis. These experimental findings serve to differentiate more clearly osteomalacia from osteoporosis and help to clarify the dietary factors which are involved.

Antibodies to Amino Acids and an Antibody Inhibitor in Relation to Cancer and Aging.

JACK G. MAKARI, *Director of Research, Muhlenberg Hospital, Plainfield, New Jersey.*

Evidence of the usefulness of the immunological approach in the field of cancer has been previously presented by the writer. Using the Schultz-Dale method, in which the guinea pig uterine segment is used as the indicator of antigen-antibody reactions, it was possible to detect to a high degree specific antigens in the sera of patients with carcinoma. This work was confirmed by Burrows of Queen's University in Belfast.

Recently the author has also succeeded in uncovering evidence of the presence of specific immunologic defects in cancer patients shown by a skin test—an auto-hypersensitivity to their own antibodies, when these antibodies were allowed to form complexes with cancer polysaccharide antigens before their injection intradermally.

In both the Schultz-Dale method and the skin test, the findings were specific to the neoplastic rather than the aging process. In this work, however, other immunological defects are described which do not seem to be limited to cancer alone, but rather to the underlying aging process.

In the first approach, the Schultz-Dale test was so modified as to detect antibodies rather than antigens in tissues and sera from cancer patients, patients with diseases other than cancer, and healthy volunteers. In this study, antibodies to amino acids, enzymes and other key substances were found in the tissues and sera of cancer patients. In younger individuals these auto-antibodies were much less apparent or absent altogether.

In the second approach, an active substance in human sera was studied. This is capable of inhibiting the flocculation of globulins in the presence of cephalin cholesterol emulsions and was described previously as a non-specific resistance factor. It was found that this inhibitor is altered with age.

It is believed that these immunological defects, namely: increased formation of antibodies to one's own amino acids, enzymes and other key substances, as well as the defect in this protective antibody inhibitor, provide two independent but interrelated mechanisms underlying the aging process and such aging diseases as cancer.

Phospholipid Metabolism of Liver and Brain Tissue of Inbred Strains of Mice with Increasing Age.

GEORGE MIROFF, JOHN H. REITER, AND W. E. CORNATZER, *Guy and Bertha Ireland Research Laboratory, Department of Biochemistry, University of North Dakota School of Medicine, Grand Forks.*

The effect of age upon the synthesis of individual phospholipids has not been previously reported. The alteration of phospholipid metabolism and distribution with increasing age was studied in brain, liver, and ascites tumor cells. The phospholipids from inbred strains of mice were labelled with P^{32} *in vivo* by injecting 1.5 microcuries of P^{32} per gram of mouse intraperitoneally. Four to 8 hours after the injection of P^{32} the brains and livers were removed from mice 1, 3, 10, 18, 31 days and adults up to 2 years of age; the organs were weighed, minced, and aliquots removed for determination of inorganic phosphorus. The remainder of the sample was used for the extraction of phospholipids with methanol chloroform solution. The phospholipids were dried *in vacuo* and recovered in chloroform and finally reconstituted in chloroform: Methanol (1:1). The total phospholipid radioactivity and chemical phosphorus were determined. The individual phospholipids were isolated and identified by silicic acid-impregnated paper chromatography. Additional experiments using silicic acid column chromatography are now in progress. The individual phospholipids were eluted. The phosphorus and radioactivity of phosphatidyl ethanolamine, phosphatidyl serine, sphingomyelin, lecithin, and inositol phospholipid were determined. Their percentage distribution in the liver was ascertained. The percentage of phosphatidyl ethanolamine in brain tissue increased with age whereas lecithin decreased slightly in the early age group. The synthetic rates of the individual phospholipids increased with age until maturity and then decreased with aging. The liver phospholipid synthetic rates rose during the 1 through 31 day experimental time. The percentage distribution and the synthetic rates of the phospholipids in brain and liver were different. The phospholipid synthetic rates of ascites cells decreased with increasing age of culture. The relationship of phospholipid metabolism to the aging process will be discussed.

Insects as Experimental Animals in Gerontological Research.

MORRIS ROCKSTEIN, *Department of Physiology, New York University—Bellevue Medical Center, New York.*

The insects represent a large group of highly complex animals co-existing with man in physical and biotic environments similar and often identical with those inhabited by man. For the investigator with a relatively limited period of productive research existence, these may indeed represent the ideal gerontological study medium. Insects possess above all a short life span (ranging from days to weeks to months for the great majority), a high reproductive potential (from hundreds to thousands of eggs per day from a single pair of parents) and ease of maintenance and rearing under controlled conditions of diet, temperature, humidity, and light. Available in pure strains, flies or bees, for example, can be obtained which will emerge on a precisely predictable day in large numbers (several thousand bees per day from a single queen bee) and which will have completed their adult lives within a matter of weeks. Such short life spans permit horizontal, replicate studies of one particular parameter of senescence or longevity, as well as vertical studies involving a number of parameters (such as diet, temperature, and parental age). Data will be cited from the author's own studies as well as those of other workers to illustrate some of these features of insects as highly desirable laboratory animals in gerontological studies.

Effect of Aging on the Growth of the Molar Teeth of Guinea Pigs*

JAMES B. ROGERS, WALTER L. JOHNSON, AND JERRY RIDDLE, *University of Louisville School of Dentistry, Louisville.*

This is a report on the growth rate of the molar teeth and the variation of the growth rate in the different age groups of guinea pigs.

Observations were made on 100 animals divided according to age into the following groups: 11 - 13 months; 23 - 25 months; 35 - 37 months; 47 - 49 months.

Post-mortem specimens of each age group were used to determine the difference in the lengths of the molar teeth of the above age groups. Living animals, kept under relatively constant dietary and environmental conditions, were observed to denote the growth rate of the molar teeth in the various age groups.

Measurements of the molar teeth of post-mortem animals showed that the length of the molar teeth from the crest of the alveolar bone to the occlusal surface was about the same in the different age groups. Measurements of the continuously erupting molar teeth of the living animals showed that the growth rate remains relatively constant throughout life of the animal.

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* Supported by Research Grant H2638 from the National Heart Institute and by Dental Student Research Scholarship, FD142, National Institutes of Health; Department of Health, Education, and Welfare.

Possible Mechanisms for Degenerative Changes in Protein Molecules Studied in Collagen and Elastin.

F. MARROTT SINEX, *Boston University School of Medicine, Boston.*

On the assumption that macromolecular changes are associated with aging, experiments have been conducted with collagen and elastin as examples of protein whose rate of renewal is limited. We have considered alterations in the native state of these proteins, such as denaturation and crystallization, and have attempted to measure the rate of one specific chemical reaction, the spontaneous release of amide nitrogen as a function of time and temperature.

The similarity of aging to the biological effects of radiation suggests that degenerative changes in macromolecules may be initiated by the attack of free radicals such as are formed by ionizing radiation. The formation of peroxides in tissue is a process which most closely parallels the effect of ionizing radiation (see Harmon, *J. Gerontol., 12:* 257, 1957). Peroxidation has been reported to occur in atherosclerotic lipid. Incubation of kangaroo tail tendon with peroxidized lipid results in a significant decrease in the critical shrinking temperature of kangaroo tail tendon, indicating that changes may occur in connective tissue in contact with peroxidized lipid which lead to a breakdown of structure.

Of the extracellular components of connective tissue, collagen is well designed for stability; elastin, noncrystalline and containing more tyrosine, should be less stable; while the mucopolysaccharides, which apparently are readily renewable, are much less stable.

Distribution of Solar Elastosis (Senile Elastosis) in the Skin.

J. GRAHAM SMITH, JR., AND ALBERT I. LANSING, *Division of Dermatology, Department of Medicine, University of Miami School of Medicine, Miami, and the Department of Anatomy, University of Pittsburgh School of Medicine, Pittsburgh.*

Elderly individuals frequently show the appearance of elastosis consisting of coarse basophilic bundles of abnormal elastic fibers in the pars papillaris of the skin usually above the collar line and below the cuff line. In this study an attempt has been made to determine whether this distribution of elastosis is due to regional differences in skin or to duration of exposure to actinic rays as determined by clothing.

Seven aged persons, 70 to 97 years, living in South Florida 20 years or longer were studied. These individuals were selected because of their prolonged fairly generalized body exposure to subtropical actinic irradiation. Photographs and biopsies were taken from areas of maximal solar exposure, the V of the neck or the forearm; moderate solar exposure, the thorax; and minimal solar exposure, the lower quadrant of the abdomen. Biopsy specimens were stained with routine and elastic tissue stains.

The largest amounts of elastosis were found in biopsies from the V of the neck and the forearm, smaller amounts were seen in the region of the thorax, and none was observed in the lower quadrant of the abdomen. These observations support the concept that the amount of elastosis is directly proportional to the degree of solar exposure. The complete absence of elastosis in unexposed areas of skin from aged individuals negates any association with aging *per se.* It is concluded that a more appropriate term for this lesion is solar elastosis rather than senile elastosis.

Studies on Acceleration of Aging by X-Irradiation of Rats.

HARRY H. SOBEL, *Institute for Medical Research, Cedars of Lebanon Hospital, and the Department of Biochemistry and Nutrition, University of Southern California, Los Angeles.*

It is generally agreed that life span is shortened in animals which have survived radiation injury. Certain clinical and histological observations lead to the concept that radiation has accelerated natural aging processes. Final acceptance of such a concept must await the demonstration that quantifiable, age-associated phenomena are accelerated following irradiation.

The hexosamine-collagen ratio (H/C) of connective tissue has been proposed as a measure of biochemical age. A study was made of H/C in skin, bone, lung, aorta, and vena cava of rats which had survived x-ray treatment administered in one dose from 15-18 months previously. It was observed that the ratios were lower than that of unirradiated animals of similar age if early phase mortality had exceeded 30%. This is consistent with the concept of accelerated aging in animals which survive irradiation damage. From preliminary observations it is suggested that in part this is due to increased fibrillogenesis following death or injury of parenchymal cells.

On the Mechanism of Aging of *Drosophila Melanogaster*.

BERNARD L. STREHLER, *Gerontology Branch, National Heart Institute, National Institutes of Health, PHS, D.H.E.&W., Bethesda, and the Baltimore City Hospitals Baltimore.*

The ease of culture, genetic control, size, life span, and responsivity to certain environmental variables have made the fruit fly, *Drosophila melanogaster,* highly suitable for experimental studies on the aging process. We have undertaken a study of the effects of three agents (temperature, ionizing radiation, heavy water) on the rate of aging and mortality behavior of individually housed *Drosophila.*

First, exposure of the flies to a number of different temperatures has yielded results confirming the classical findings of Loeb and Northrop, and Pearl. Second, the subjection of the flies to brief thermal shocks sufficient to kill 50% of them has not produced the increase in the age-specific death rate of survivors which would have been expected if the flies had been aged by the treatment. It is therefore concluded that the classical acceleration of the aging process at higher temperatures (20-30 C. vs. 12-20 C.) is not due to high activation energy denaturation processes but rather to an increased rate of indirect incidental damage as a by-product of metabolism or the accumulation or exhaustion of a substance. Third, we have observed that exposure to 4400 roentgens (x-rays) doubles the life span of *Drosophila.* (This dose level was not immediately lethal to any of the flies.) This finding is in apparent conflict with somatic muta-

tion theories of aging. Fourth, 20-40% heavy water accelerated the rate of aging as measured by the slope of Gompertz plot by about a factor of 2.

Effects of Genetic Constitution and Maternal Age on the Aging Process in Mice.

LEONELL C. STRONG, *Biological Station, Roswell Park Memorial Institute, Springville, New York.*

From a single outcross between a male mouse of a polydactylous descent and females of the C_{57} inbred strain 5 descents have been continued, selection being based, in the separated descents, upon the age of the mothers at the time offspring were born. These descents are <100, 101-200, 201-300, 301-400, and 401-500 days. The early maternal age descent has reached 30 generations of inbreeding. The average litter spacings between litter 1 to litters 8 compared to litter spacings between litters 9 to 14 have been as follows: F_1 - F_8,-5.1 days; F_8 - F_{10}, -3.7 days; F_{11} - F_{15}, 0 days; F_{16} - F_{20}, +0.7 days; F_{21} - F_{25}, +2.2 days; and F_{26} - F_{30}, +4.9 days. The values of litter spacings between F_1 - F_5 generations of inbreeding for the 5 independent material age descents have been in sequence <100, -5.1 days; 101-200 days, -4.0 days 201-300 days, -3.8 days; 301-400 days, -2..0 days and 410-500 days, -1.0 day. Thus it is demonstrated that in the aging process as measured by the ability of a mouse to produce litters of young (litter spacings) there is indicated not only a genetic influence as indicated by the process of inbreeding (conversion of the heterozygous state to homozygosity) but also a maternal influence as measured by the age of the mother at the time of birth of her offspring.

Osteoclasts and the Aging Skeleton: A Cytochemical and Autoradiographic Study.

EDGAR A. TONNA, *Medical Department, Brookhaven National Laboratory, Upton, Long Island.*

It was the object of this investigation to study the following in normal rats from birth to old age, namely: 1) changes in osteoclastic population of the femoral periosteum and metaphysis, 2) the association of sulfated mucopolysaccharides, and 3) the uptake of S^{35} sulfate.

Cytochemical methods (Toluidine blue 0, Colloidal Iron, and Periodic Acid Schiff) for *in situ* localization and distribution of sulfated acid mucopolysaccharides were performed. Mitochondria were visualized by Regaud's iron hematoylin and autoradiographs were prepared following S^{35}-sulfate injections.

Large numbers of osteoclasts were found at the perichondral zone of the periosteum at 5 and 8 weeks of age. Osteoclasts were not seen in the periosteum at the other ages studied. The appearance of osteoclasts at the metaphyses is well known. These cells are found predominantly between the ages of 1 and 26 weeks of age. Their frequency is highest at a period at which elongation of bone is greatest.

At any age that osteoclasts were observed, whether they were at periosteal or metaphyseal sites, their cytoplasm revealed an abundance of fine red granules of various sizes after toluidine blue 0 and blue granules after colloidal iron. Autoradiographs showed that S^{35} was taken up by osteoclasts, however, not in greater preference to osteoblasts. The mitochondrial population of osteoclasts always seemed abundant irrespective of age.

In the periosteum, numerous transitory stages were observed and recorded which point to the formation of periosteal osteoclasts from periosteal osteoblasts.

The findings indicate that osteoclasts are dynamic cells which, as is well known, can appear and disappear from a region within a short period of time. Osteoclasts probably originate from or dissociate into pre-existing cells, such as osteoblasts. When they are present, they contain numerous mitochondria. Cytochemical staining reveals an abundance of cytoplasmic granules which are believed to be sulfated acid mucopolysaccharides or their precursors. Autoradiographs also show that the S^{35} uptake is similar, per unit area, to that found in osteoblasts, yet a greater amount is actually present in osteoclasts because of their large size. Interestingly enough, the population of osteoclasts does not seem to age with the aging animals as is typical of periosteal osteoblasts.

SECTION ON CLINICAL MEDICINE

Abstracts edited by Robert T. Monroe, M.D.

Attitude of the Aged Toward Physical Handicaps.

IRA M. ALTSHULER, L. C. REPICCI, L. L. MCKENZIE, H. J. WELLS, AND J. B. JENKINS, *Eloise, Michigan.*

The aged are more apt than any other group to become afflicted with various physical handicaps because of the inevitable decline in bodily functioning. The manner in which these people perceive these debilitating afflictions, how they attempt to cope with them and the attitudes that they develop, are of crucial significance in regards to the type of adjustment they make.

This study investigates whether working aged persons who have physical defects, manifest, as a group, more accepting and wholesome attitudes in regards to physical handicaps than individuals of a similar group who do not work.

To answer this question, 60 patients from the infirmary division of Wayne County General Hospital were randomly selected and divided into two groups. All subjects were 65 years old or older and all have manifest physical defects. The experimental group worked for remuneration at various jobs within the hospital environment and the control group did not work.

Members of both groups were administered 10 cards of Murray's Thematic Apperception Test which were modified so as to depict various types of physical handicaps. A modified variation of the Bellak system of administration and scoring was used to evaluate the various defense mechanisms according to the degree to which they reflect positive or negative attitudes.

Results indicate tnat the aged person who is physically handicapped but who works tends to cope more effectively with his handicap and manifests more positive attitudes towards his handicap than do the non-workers

Suggestions for further research are made.

Electromyographic Studies of Common Gait Patterns in the Geriatric Patient. A Preliminary Report.

ROLF G. BAGINSKY, *Assistant Chief Physical Medicine & Rehabilitation Service, Bedford, Massachusetts.*

The more common disorders of gait particular to the older age group are discussed. Electromyographic studies with surface electrodes of these gait patterns in 150 patients age 60 and over are reported. Clinical improvement and electromyographic changes are correlated.

Clinical Plethysmography in the Preventive Management of Peripheral Vascular Disorders of the Aged.

LEWIS COHEN, *Sinai Hospital of Detroit.*

The effective management of occlusive arterial disorders depends upon an accurate evaluation of the peripheral circulation. In addition to clinical observations it is now possible by means of an electronic pneumoplethysmograph to obtain objective data concerning neurogenic and non-neurogenic influences on digital blood flow. It is possible to detect early organic and vasospastic changes before irreversible damage occurs.

Recorded measurements of volume pulsation, systolic blood pressure gradients of the extremities, pulse wave contour, relative blood flow, and peripheral resistance obtained before and after vasodilation provide quantitative data which demonstrate the following: (a) functional and organic components of vascular impairment; b) selection of patients for lumbar sympathectomy; c) extent of collateral circulation; d) location of obstructions in the arterial system; and e) the effect of various therapeutic agents on peripheral flow.

The use of this high-sensitivity instrument is of value in the clarification of such obscure symptoms as night cramps, arm and leg pains, paresthesias and weakness, gangrene, leg ulcers, and backache. Cervico-brachial syndromes in which electromyograms are normal often can be demonstrated to be due to vascular causes. This procedure has proved to be relatively rapid, reliable, reproducible, and acceptable to the patient. The early detection of minimal vascular changes is of particular value in middle-aged patients who are faced with serious social and vocational changes due to progressive vascular disease.

The application of this diagnostic procedure is shown in patients having arteriosclerosis obliterans, thromboangiitis obliterans, scleroderma, fractures, phlebitis, and amputations.

An Evaluation of Liver Function Studies in the Aged.

THEODORE COHEN, EMANUEL LIPSCHUTZ, LEO GITMAN, AND HERMAN BOLKER, *Brooklyn Hebrew Home and Hospital for the Aged, Brooklyn.*

Few studies have been performed in the past evaluating the physiologic status of the liver in aging individuals. The literature contains some sparse reports of anatomic as well as functional changes. The latter consist of a high incidence of abnormal liver function studies. Our clinical experience is such that we are unable to concur with the previous reported results in the geriatric patient.

In order to investigate the problem further, we selected 75 patients over the age of 65 years who were free of any relevant disease and performed a battery of standard liver function tests, including the more recent serum enzyme determinations.

Our results appear not to show an unusually high incidence of abnormal tests.

Intramucosal Insert: A Method of Maxillary Denture Stabilization.

A. NORMAN CRANIN AND SAMUEL I. CRANIN, *Brooklyn.*

A technicque has been developed which encourages the oral tissues to re-epithelize into a new shape. Buried or semiburied foreign bodies are not utilized; rather a method is used which induces a plastic recontouring of the mucosa around the nonreactive intramucosal insert heads. The tissues, in healing, constrict about the cervix, causing positive retention about each head. After healing, the tissues appear moist, pink, and healthy. A criterion of success is ascertained by directing the air syringe at each receptor site. It should be barely visible but should open slightly on air pressure to reveal a deep well-formed crypt. When the insert is placed too deeply into the denture, an improperly formed receptor site results. The remedy for this or any other persistent problem is to remove the insert, recontour the denture, and permit the tissues to fill in. After repair is completed, the insert may be replaced if need for additional retention is apparent.

After working with these retentive devices for a period of time, the operator not only becomes facile with them, but acquires talents which help him to employ them in new and original ways. They may be used in free-end saddle partial dentures when periodontally involved abutment teeth do not offer the required stability. They may also be used to assist in the stabilization of surgical protheses and obturators. The surgical procedure is minor, the prosthetic technique simple, and the results encouraging. The dentist might find the technique useful with older patients since the risk is minimal and the potential benefits gratifying.

Physical Findings in the Ambulatory Octogenarian.

JAMES F. CUMMINS, *Veterans Administration Outpatient Clinic, Boston.*

We have examined over 150 octogenarians in this Clinic. These men are healthy, ambulatory, energetic and able to cope with current life situations. Histories are remarkably free of infectious disease; few have had any accidents severe enough to require hospitalization. Physical examination reveals only 6 with blood pressures consistently greater than 150/100. The commonest ocular manifestation is macular degeneration, although cataracts are frequent; however 50% of the veterans still read newspapers without difficulty. Hearing aids are utilized by 40% of this group of patients. Almost 100% use dentures. Chest examination demonstrates senile kyphosis with compensatory emphysema. One-second vital capacity is well-maintained. Extensive respiratory function studies are being performed. Very few veterans show cardiac enlargement, although 75% have had one or more episodes of congestive failure; 17 have previous

history of electrocardiographic evidence of myocardial infarction, and the remainder have varying degrees of normal electrocardiograms. Seven men have had proven duodenal ulcers, but no major problems of the gastrointestinal tract can be demonstrated and no carcinoma of the stomach has been observed. Benign prostatic hypertrophy is a major problem in this age group and 8 carcinomas of the prostate have been treated. Two severe cases of angiitis obliterans have been observed, and minor intermittent claudication is frequently seen. We have seen only 2 with Parkinsonism palsy. Deep tendon reflexes are preserved but there is frequent loss of vibratory sensation. All of them have smoked but no lung cancer is seen. Two have a past history of chronic alcoholism. The commonest diagnoses are arteriosclerotic heart disease ± mild failure, osteo-arthritis, osteoporosis, benign prostatic hypertrophy, pulmonary emphysema, and macular degeneration. The commonest drugs used are digitalis, chlorothiazide, potassium chloride, and minor analgesics. Thirteen deaths have occurred since the start of the study.

Neurologic Findings in County Hospital Patients.

ROBERT D. CURRIER, *Department of Neurology, University of Michigan Medical Center, Ann Arbor.*

A neurologic examination was performed on every patient in two county hospitals. This was part of a general medical, physical medical, social, and psychological evaluation. An attempt was made to arrive at a definite neurologic diagnosis and, if possible, determine the cause. The results were striking.

A variety of neurologic disease was found. A breakdown into types of disease and presumed etiology is given. Seventy-five % of the patients were in the hospital because of their neurologic difficulty. Only 9% had normal neurologic examinations.

Arteriosclerosis was the probable causative factor in over half of the patients who were in the hospital because of neurologic disease. The importance of disease of the nervous system as a cause of chronic disablement and of arteriosclerosis as the most common etiology is emphasized. The need for further study in the general field of changes in the nervous system with aging is acute.

Physical Problems of Aging People.

ROBERT H. DOVENMUEHLE, *Duke University, Center for Study of Aging, Durham, North Carolina.*

(Abstract not received.)

Sexual Activities of the Normal Aging Individual.

JOSEPH T. FREEMAN, *Philadelphia.*

A special study of sexual abilities and attitudes in older individuals has been instituted because of a lack of definitive information about this particular aspect of aging.

Aside from being a proper sphere for objective gerontologic investigation, the clinician has two needs for this information.

1) Complicated symptoms can arise from forces based in sexual conflict. Some organic diseases can be traced to mechanisms involved in the sexual behavior of older persons. Unusual sexual expressions and deviations can be carried over in an unresolved fashion from younger years. New sexual proclivities can arise from the change in common inhibitions instituted by pathologic processes associated with aging.

2) Intricate medico-legal problems are involved not only in that which is considered average, but also in that which has been labeled abnormal or bizarre sex practice in older people.

A great deal of resistance has been met in the effort to establish a study of the normal sexual characteristics of older age.

A questionnaire was devised by which to obtain answers from normally oriented older people. Most of the answers indicated a sincere and intelligent understanding of the problem, with a desire to help to illuminate the issue. The results of the summated answers, added to clinical and sociologic observations, will serve as a basic, if preliminary, premise for more advanced studies of this category of gerontology.

The First Fifty Years of *Geriatrics* (1909-1959).

JOSEPH T. FREEMAN, *Philadelphia.*

The golden anniversary of the term geriatrics occurred in the year 1959. Within 11 years it was incorporated in a standard American dictionary. The field which it designated took much longer to be accepted as a valid clinical and biological category.

From the gerontologic point of view, the scene has undergone incredible changes in human and in animal existence during this half century.

Some substance was given of the old dream of finding ways to increase the span of life beyond that which seemed to be human limits. A kindred association was the suggestion deriving from experimentation that a wedge might be able to be driven between the two disturbing halves of the liaison which is made up of longer life and inevitably conjoined physiological impairments.

For one reason or another, the golden recognition is proper, to the accomplishment of Dr. I. Leo Nascher, to the accomplishments of the world of men. As the daily flow of gerontologic ideas accumulates in what in panorama is a true view of the large forces of the future, every segment of the thinking world becomes involved. Every focus of investigation, every demonstration of fact, from the laboratory to the mature interpretation of the data, is joined in minds trained to the study of the features of aging.

Uses of a Geriatric Clinic.

SAMUEL GERTMAN, *Miami, Florida.*

(Abstract not received.)

Establishing a Research-Oriented Clinic for Spanish-American War Veterans.

OLIVER J. HARRIS, AND JAMES F. CUMMINS, *Veterans Administration Outpatient Clinic, Boston.*

It has been found that approximately three times the number of Spanish-American War Veterans survive as would ordinarily be anticipated. Furthermore, it was the impression of the Staff at the Boston V.A. Outpatient Clinic that these veterans seemed healthier than their stated age. To provide for their medical care and to

investigate the reasons for their good health and longevity, a multi-disciplinary research-service Geriatric Clinic was established at the Outpatient Clinic in February, 1958. The Spanish-American War Veteran averages 81 years of age. He was born at a time when medical knowledge was in its infancy, when food and dietary habits were essentially uninfluenced by the knowledge of science, and when sanitation as we know it today was non-existent. Thus, this group is unique today as the last survivors of the process of natural selections in our country.

The paper presents the ingredients of developing a clinic program which combines medical outpatient care with intensive inter-disciplinary research. These involve methods of recruiting and motivating the veterans who are normal, non-institutionalized community residents, and the necessary arrangements for financing, staffing, and conditioning the multi-disciplinary research projects.

Current studies of the veterans include physical examination and history, dietary history, social history, hematological and other laboratory studies, psychological studies of intellectual functioning and personality, electroencephalogram, electrocardiogram, tests of vital capacity, x-rays of skull, chest, and heart measurements and of vertebral column and long bones, as well as complete anthropometric measurements.

To be discussed are problems peculiar to a combined research-service clinic such as methods of motivating the older patient to participate in extensive research and evaluating the degree of mutual interferences between treatment and research procedures.

Institutional Use of a New Psychic Energizer (Ro 5-0831)

RAYMOND HARRIS, *Assistant Medical Director, Ann Lee Home; Chief of Cardiology, St. Peter's Hospital, Albany,* AND WOLFGANG HOCHCHER, *Interne, St. Peter's Hospital, Albany.*

The advent of psychic energizers provides a drug potentially useful in the aged. Many elderly people, especially those long confined to an institution by age or illness, develop some form of psychiatric disorder arising from functional brain disease, organic brain lesions, or from a subtle distintegration of the psyche induced by the apathy and dull routine of institutional living. Studying the safety and value of a newly developed analog of Marsilid, Ro 5-0831 (Marplan) in elderly people, we administered this psychic energizer to 40 residents of the Ann Lee Home who had a variety of somatic and psychic complaints, depression or confused behavior. The drug was given in double blind study for three months during which time complete clinical and laboratory observations were recorded. These included repeated physical and mental examinations, behaviorial ratings, blood pressure checks, electrocardiograms, x-rays of the heart and lungs, liver function tests, and blood and kidney tests. Improvement in attitudes and cooperation was noted. Rehabilitation efforts were enhanced. No liver or renal damage was detected. Cardiovascular data and other results will be discussed.

Hypothyroid State of the Older Individual.

SAMUEL JACOBSON, *Wayne County General Hospital, Eloise, Michigan.*

(Abstract not received.)

Detection of Tumors in Man by the Skin Testing of Polysaccharide-Antibody Complexes.

JACK G. MAKARI, *Director of Research, Muhlenberg Hospital, Plainfield, New Jersey.*

During the annual meeting of the American Public Health Association last November, I presented original work on a blood test and a skin test for the detection of cancer. Both of these approaches are based on definite immunological principles. The first test detects cancer antigens in the serum of patients utilizing the Schultz-Dale procedure in which the sensitized guinea pig uterine segment is used as the indicator of antigen-antibody reactions. In the second test the skin is used as the site for antigen-antibody reactions following the intradernal injection of polysaccharide-antibody complexes.

The blood test has been confirmed on a large series of cases by Burrows at Queen's University of Belfast where he obtained in pathologically proved carcinomas positive results of 96.8% (as compared to our 96.7%) and 3.3% (compared to our 4 to 5%) in non-carcinomatous disease. This establishes the blood test as a definite aid for carcinoma diagnosis.

The results of the skin test on 200 individuals reported earlier revealed this to be a very useful screening method for all tumors. It was found then that the test was positive in all cases with early localized carcinoma, in 85% of carcinomas with local extension, and in 60% of metastatic carcinomas. It was also positive in all solid benign tumors and in 67% of cystic benign tumors. In volunteers 31% positives were obtained, while only 10% positives were obtained in patients with other diseases.

This paper reports confirming results obtained with skin tests on 250 additional cases (both patients and volunteers). Furthermore, a new modification of the skin test using trypsinized serum has markedly increased the sensitivity of this screening procedure for tumors.

The results of the skin tests to the various polysaccharides used reveal patterns of great help in indicating whether a tumor is early, whether it has extended locally, or whether it has metastasized to distant organs. This skin test is of help then, not only as a tumor screening method, but also as a tool in assessing prognosis and recurrence of tumors after surgery or radiotherapy.

Further Research in the Field of Analeptic Drugs in Therapy of the Aged.

BENJAMIN O. MORRISON, *Instructor, Louisiana State University School of Medicine and Medical Service, LSU Unit, Charity Hospital of Louisiana at New Orleans, and LSU Medical School and The Gastro-Enterology Clinic, Touro Infirmary, New Orleans.*

This report is based on a study of 61 patients from the Medical Services of both a general and a private hospital. A large percentage of these patients were arteriosclerotic; others were suffering from serious physical and mental illnesses.

All were treated orally with tablets with the exception of 4 who were given ampules intramuscularly. Forty-four of the 61 patients benefited from this therapy, showing an over-all improvement of 72.13%. All 5 patients on the ampules improved (in addition, one of these was given tablets). The most striking change was

in mood and mental behavior, but better nutrition was also noted.

A compilation of the results achieved in the different systems shows that cardiovascular, genito-urinary, hematopoietic, and metabolic system diseases were helped to the greatest extent; respiratory and central nervous system diseases were favorably changed to a lesser degree.

The greatest improvement with the tablets was reached with a dosage of 150 mg. Change was found to occur as early as the third day after initiation of therapy. Ten days was demonstrated as the average length of time to reach some appreciable results. There were practically no side effects. Bone marrow was not depressed and liver function remained unimpaired.

As 72.13% of the patients showed some degree of response with this therapy, it is believed that W-1597 is a safe and useful analeptic drug in the treatment of other diseases encountered in this study as well as in the treatment of arteriosclerosis.

Sexual Activity and Attitudes in Older People.

GUSTAVE NEWMAN, AND CLAUDE R. NICHOLS, *Department of Psychiatry, Duke University Medical Center, Durham.*

In a comprehensive, inter-disciplinary study of geriatric subjects living in the Durham, North Carolina community, data have been gathered and assessed regarding the sexual activity of older people. Subjects ranged from 60 to 93 years of age, and included males and females of the Caucasian and Negro races. Analysis of these data shows surprisingly little correlation of sexual activity with age and race, but in this sample, females have less sexual relations than males. The subjects also rated themselves on the strength of their sexual urge in youth and in older age, and a comparison of the two ratings shows a remarkable constancy of the experiencing of the sexual urge within individuals throughout life. Although older people experience decline in sexual activity, these data show that, given the conditions of reasonably good personal health and marital partners who are also physically healthy, elderly persons continue to be sexually active into their seventh, eighth, and ninth decades.

Studies in Geriatric Mental Illness. A Preliminary Report.

MIRON W. NEAL, *Project Psychiatrist, Geriatrics Research Project,* The Langley Porter Neuropsychiatric Institute, and Research Associate, University of California School of Medicine, San Francisco,* AND ALEXANDER SIMON, *Principal Investigator, Geriatrics Research Project;* Professor and Chairman, Department of Psychiatry, University of California School of Medicine, and Medical Superintendent, The Langley Porter Neuropsychiatric Institute, San Francisco.*

In order to determine the nature and over-all scope of mental illness in the geriatric age group, and as part of a 5-year interdisciplinary study, 600 consecutive geriatric patients admitted to a metropolitan psychiatric service are being screened for gross medical, psychological, and social characteristics during 1959. A concurrent survey of the city's non-hospitalized geriatric population will locate certain non-hospitalized groups for comparison with the hospital population.

On the basis of analysis of the year's data and follow-up information, subgroup samples will be drawn from future admissions for intensive psychiatric, biochemical, psychological, neuropathological, and sociological studies.

The first 150 cases† are analyzed by diagnostic categories, by degree of need for psychiatric hospitalization, and by disposition from the receiving service.

Of special preventative and theoretical interest are the group which comprised 30% of all patients showing organic brain syndromes and which is classified as mixed. The history of this group is that of a borderline, senescent psycho-social adjustment interrupted by abrupt psychological decompensation which ends in hospitalization with a psychiatric clinical picture of a senile psychosis. Detailed study, however, usually reveals physiological or psychological stress associated with the psychological decompensation. The most common associated events are malnutrition, borderline congestive heart failure, or disruption of immediate family environment.

In the absence of a clear-cut history of steadily progressive senile deterioration, such patients should be considered as undergoing a potentially reversible senile crisis until a trial of appropriate physiological and psychological treatment proves otherwise.

* The Geriatric Research Project, The Langley Porter Neuropsychiatric Institute, is sponsored by a grant from the National Institute of Mental Health.

† By the time of presentation of this paper (November), analysis of approximately 300 patients will be available.

Nutritional Requirements of the Older Person.

JAMES M. ORTEN, *Professor of Physiological Chemistry, Wayne State University College of Medicine, Detroit.*

Extensive studies of the nutritive requirements of reasonably healthy elderly individuals, of the 65 and over age group, indicate that there are no striking differences from those of younger normal adults. The qualitative needs to replace losses due to everyday wear and tear of tissues continue during old age much as in the post-adolescence period of life. However, there are quantitative changes in nutritional requirements, possibly due in some cases at least to cumulative pathological changes in tissues. The need for calories usually decreases primarily as a result of decreased activity. If the caloric intake is not adjusted accordingly, obesity with its attendant hazards is a likely consequence. Also, there is considerable evidence of a decrease in carbohydrate utilization in elderly subjects. The requirement for protein in older individuals is certainly no less than that of the middle-aged adult, and several careful studies have suggested that more protein is required to maintain nitrogen balance in the old age group than in middle-aged persons. This increased need applies to both the essential and non-essential amino acids. It may be a result of poorer absorption or utilization, or both. The need for other essential nutrients, including the vitamins and minerals, likewise continues at about the same level as during the middle-age period of life, cobalamine, calcium, iodine, and iron perhaps requiring some special attention. It is well-established today that other factors—economic, psychological, physiological, and pathological—also affect the nutrition of the older person. Thus, good nutrition of the senior citizen has been described as a blend of good food, good cooking, good health, good environment, good companions, and good reasons for eating.

A Hospital-Connected Sheltered Workshop for the Severely Disabled and the Aged.

MIECZYSLAW PESZCZYNSKI, *Associate Professor of Physical Medicine and Rehabilitation, School of Medicine, Western Reserve University; Chief, Department of Physical Medicine and Rehabilitation, Highland View Hospital, Cleveland.*

This is a report of our experiences in organizing a sheltered workshop connected with a chronic hospital. The methodology as well as the results of some research into the vocational capabilities of the severely disabled and aged are presented. Problems applicable to similar hospital settings are discussed.

Dizziness: Its Relationships Within the Aging Process.

JUAN A. PONS, *Adviser in Gerontology, Department of Health, San Juan, Puerto Rico.*

Of 207 subjects 60 years of age or older, all living at home and fairly active, 54.1% exhibited dizziness as a complaint. Age, sex, and race were not significant etiologic factors, but the socio-economic status was a significant factor, the symptom being more frequent in the lower group. The relative frequency of 140 physical, emotional, and social health variables in those with and without dizziness was matched. Significantly, the dizziness group had, from childhood to the present, more diseases and more experiences related to illness. Also, at present, they had significantly more symptoms referable to the cardiovascular system and more findings on physical examination which, together with the history, lead to significantly more diagnoses of cardiovascular disease, particularly arteriosclerotic-hypertensive disease. However, X-ray and electrocardiographic examinations did not corroborate this preponderance. The level of the blood pressure was in no way related to dizziness, but there is a suggestion that a drop in diastolic blood pressure on standing from the recumbent position is related to orthostatic dizziness. At high levels of significance, variables which reflect an unfavorable perception of their life situations were more frequent in the dizziness group. It would seem as if among those who suffer from dizziness in old age there is a large representation of those who have had lifelong difficulties in adapting to changes in their life situations, the sensitive equilibratory mechanism now responding readily to bodily, physiological, and psychological stimuli, themselves fluctuant, through relationships which are deeply rooted in the remote part and enlivened by the insecurities of old age.

Medical Care Needs and Rehabilitation Potential of Patients in Michigan's County Hospitals.

EDWIN M. SMITH, *Assistant Professor of Physical Medicine and Rehabilitation,* RALPH L. BRANDT, *Assistant Professor of Internal Medicine,* AND ROBERT D. CURRIER, *Assistant Professor of Neurology, University of Michigan School of Medicine, Ann Arbor.*

The medical and functional status of patients in two Michigan County Hospitals has been evaluated by means of comprehensive physical and functional examinations and selected laboratory tests. On the basis of this evaluation, types of care programs required by the patients have been identified together with the disorders responsible for placement of patients in the different programs. Of the 125 patients examined, approximately one-third could be expected to benefit significantly from a long-term active treatment program of the type offered in modern chronic disease units. Disorders involving the nervous, musculoskeletal, and cardiovascular systems predominated in this group, resulting in a high incidence of disabilty requiring physical and functional rehabilitative procedures. Another third of the patients required varying degrees of supervision in their daily living, but did not need nursing care or special medical attention. This group's inability to manage its affairs was commonly the result of mild senility or an accumulation of infirmities of age. The remaining third needed permanent maintenance nursing, for the most part because of advanced senility. The fact that three basically different types of care programs are required to meet the needs of patients in County Hospitals raises the question of what role those institutions should serve. The possibility of the establishment of long-term active treatment programs in the County Hospital is discussed. The environment needs of the patients requiring simple supervision are also considered.

Hormonal Effects on the Aged Male Sebaceous Gland.

J. GRAHAM SMITH, JR., AND FELIX R. BRUNOT, *Division of Dermatology, Department of Medicine, University of Miami School of Medicine, Miami.*

The influence of certain sex hormones on the aged male sebaceous gland was studied. Sebum excretion was measured by placing a fresh Whatman No. 42 filter paper on the non-defatted skin of the forehead every 5 minutes over a period of 45 minutes for three consecutive days and coloring the sebum black by exposure of the papers for two minutes to the fumes of osmium tetroxide. After complete darkening had occurred, the degree of darkening was measured with a photoelectric densitometer. The sebum excretion levels of 10 men aged 67 to 89 were determined. Three of the men then received 200 mg. testosterone enanthate and 5 of the men received 250 mg. hydroxyprogesterone caproate intramuscularly once weekly. Two men received no injections and served as controls. Hormones were administered for 10 weeks and sebum excretion levels of the entire group were determined at 4, 7, and 10 weeks after therapy was begun. Four weeks after treatment was stopped the levels were determined again.

The pretreatment, treatment, and posttreatment levels of sebaceous excretion of the men who were controls and the men treated with hydroxyprogesterone caproate showed no significant differences. Two of the three men treated with testosterone enanthate showed significant increases in sebum excretion on all three occasions they were tested after treatment was begun. Four weeks after treatment was stopped, all three men treated with testosterone enanthate showed significant reductions from the treatment levels.

SECTION ON PSYCHOLOGICAL AND SOCIAL SCIENCES

Abstracts edited by Marion E. Bunch, Ph.D.

Age Differences in the Frequency of the GSR During a Conditioning Experiment.

JACK BOTWINICK AND CONAN KORNETSKY,* *Section on Aging, National Institute of Mental Health, National Institutes of Health, Public Health Service, Department of Health, Education and Welfare, Bethesda.*

Male subjects in two groups (approximate mean ages = 72 and 20 years) were compared with respect to three frequency measures of Galvanic Skin Response (GSR) during a conditioning experiment. The GSR as a measure of sympathetic activity may be useful as an index of general level of activation or reactivity. Thus the present data provide a basis to infer possible age differences in general reactivity.

The older group comprised 39 volunteer subjects who either were without apparent disease of any kind or with some type of non-interfering ailment. The younger group comprised 9 healthy volunteer subjects who were quartered in an NIH ward. Each subject was presented with 3 shocks to the fingers (US), each shock being 1.1 ma for 0.1 sec. Following this a tone (CS) was presented for as many trials as necessary to extinguish the GSR. CS was then paired with US for 15 trials. The interval between CS and US was 4 sec. Extinction trials followed. All GSR recordings were made with a Fels dermohmmeter and Fels electrodes attached to the soles of the feet of the subject in supine position.

Measures used were the number of: 1) trials to extinguish the GSR prior to conditioning, 2) conditioned responses during the 15 conditioning trials, and 3) trials to extinguish the GSR after conditioning. It was found that the older subjects extinguished more readily and conditioned less readily than younger subjects. This was taken as evidence for a reduced level of reactivity with age.

* Now at Department of Pharmacology and Experimental Therapeutics, Boston University School of Medicine.

Expectations for Older Persons by Residents of a Rural Community: Solution of Personal Problems and Use of Sources of Help.

JOSEPH H. BRITTON, *The Pennsylvania University, University Park.*

Statement of Problem: To determine: 1) what adult members of the community recommend as solutions to older persons' problems; 2) use and availability of professional and organizational services for the aging.

Procedure: An adult member of each household (N=487) in a rural community was interviewed to discover attitudes toward the behavior of older persons. Interviewees were presented with hypothetical situations and asked to suggest appropriate solutions to certain problems of older persons. Their responses suggest sources of help.

An inventory was made of organizational and professional services for older adults in the study community. Interviews with each professional person and an officer or leader of each organization revealed the extent to which services or programs were designed for or used especially by the aging.

Results and Conclusions: A variety of solutions to problems of lonesomeness, poor health, chronic physical disability, senility, and financial difficulties are suggested. Responses are related to factors of age, sex, education, and occupation of interviewees. There is little reliance on professional services, except the physician and minister and, in the case of economic crisis, the public assistance office. There is often an attitude of needing to accept, postpone, or relieve the inevitable. The survey of professional services revealed that little psychological or psychiatric assistance was sought or utilized by older adults in the community. The findings are interpreted in terms of a traditional orientation toward independence and self-sufficiency, as well as responsibility such a view puts on lay leaders and professional persons not specifically trained in helping others with personal problems.

Two Thousand Years of Married Life.

E. W. BUSSE AND C. EISDORFER, *Duke University Medical Center, Durham.*

During the course of its investigations, the Duke Geriatrics Project has examined 31 married couples. These aged community volunteers were evaluated using a battery of psychological, psychiatric, physical, and social history techniques. Subjects in this study range in age from 59-90, with a mean age of 69.6 years (71.8 for males and 67.4 for females), and have been married for a mean of 38.2 years. This paper will review the findings based on psychological and psychiatric examinations. The psychological examinations include individual full-scale intelligence tests (Wechsler-Bellevue I, or WAIS) and the Rorschach test, which have been administered to each subject. The Rorschach has been scored both for routine evaluation, as well as according to the developmental criteria of Primitive Thought, Functional Integration, and Content Score. The psychiatric interview has been especially oriented toward an understanding of the psycho-neurotic reaction patterns of these subjects as well as their present adjustment and level of sexual activity.

An analysis of intellectual, developmental, sexual, and personality factors in those couples who rate as happily married or unhappily married will be presented.

Anxiety Components in Older Persons.

EUGENE BYRD, *Research Director, Division of Gerontology, Department of Medicine, University of Miami School of Medicine, Miami.*

Current research and theory of anxiety is briefly but critically reviewed, stressing particularly the findings of multivarate analysis. Anxiety traits and states are identified and differentiated for discussion and research purposes. Personality test (Cattell 16 PF) data are presented on a heterogenous group of older persons that support the hypothesis that anxiety trait levels increase in later years. There remains the problem of identifying the sources of this trait. The primary anxiety factors of ego strength, timidity, protension, guilt proneness, anxiety control, and ergic tension are discussed in reference to aging.

Critical Flicker Frequency and Shortest Noticeable Dark Time as a Function of Behavioral Efficiency.

NEIL W. COPPINGER AND RAYFORD T. SAUCER, *Veterans Administration Center, Kecoughtan, Virginia.*

Extreme variability among persons in later maturity and old age demand more adequate criteria of aging than simply chronological age. It is suggested that criteria established in terms of behavioral efficiency and measured by traditional laboratory methods, especially in the area of visual perception, may contribute toward this end.

This paper, one of a series attempting to ascertain visual stimulus combinations which will maximize individual differences, describes the results obtained on CFF thresholds where, in one condition, the light-dark ratio was held constant and in the other, the dark time was varied while the light time was constant (shortest noticeable dark time).

Subjects were divided into three groups and ordered on a rough continuum of behavioral efficiency ranging from non-institutionalized, self-supporting, young men; through institutionalized, partially employed, older men; to institutionalized, infirm, elderly men.

Between-group differences were significant for both conditions but the results indicate that SND has a greater discrimination potential than does CFF with a 1:1 LDR.

Sources of Free Time in the Mature Years.

W. F. COTTRELL, Miami University, Miami.

The sources of free time have a good deal to do with the way that time will be distributed. Through science and technology man has been able to lengthen life, reduce early mortality and morbidity, and channel energy from sources other than plants to do his work. He could meet the minimal demands for survival with only a small part of the labor hours that the population could devote to production. In fact, however, that is not the course of action regularly taken. In certain areas we have held production constant and reduced the man power needed, in others the same number of people work shorter hours and less days per year, in others reduced prices and increased volume have kept about the same number of people busy. The rest of the gains have been taken in the form of new goods produced by people taking new roles.

There were few old people in low energy society and hence few roles for them to play existed in the culture. The place the increasing number of aged can occupy is not sanctioned by tradition. We can therefore see how much of increased productivity will take the form of increased free time for the aged only by observing specific social trends. Trends in the age composition of the labor force provide one source of evidence. Studies of careers, showing how employment varies with class, education, and occupation of the aged provide another. Increased studies showing exactly what the sources of free time are and how they are related to changing values, institutional patterns and the character of those who continue to be employed will let the social gerontologist know more accurately for whom free time activity should be provided.

Intellectual Functioning of Fifty Spanish-American War Veterans.

ANDREW S. DIBNER AND JAMES F. CUMMINS, *Veterans Administration Outpatient Clinic, Boston.*

The purpose of this study is to add to our empirical knowledge of the intellectual functioning of normal, non-institutionalized older persons. The Wechsler Bellevue Scale (Form I) was administered to 50 Spanish-American War veterans (average age 81 years) who live in the Greater Boston Area and who responded to an invitation to attend the research-oriented Geriatric Clinic at the VA Outpatient Clinic. The Wechsler-Bellevue Scale was administered as part of a larger battery of psychological tests in a multi-disciplinary research program.

The average Full Scale IQ of the group was found to be 109, Verbal IQ 110, Performance IQ 112. Subtest variability, indicating differential decline of different intellectual functions, was found to be similar in most respects to those results reported by other investigators with aging samples, and despite the group's high average intelligence, the average Deterioration Quotient seems to follow an extrapolation of the empirical curve determined by Wechsler.

A comparison was made of the performance of 23 subjects aged 73 to 79 years with that of 27 subjects aged 80 to 89 years. Qualitative findings on the nature of conceptual thinking in these aging subjects is described as well as an analysis of the effects of using standard time limits or extended time limits with the Wechsler Scale.

Rigidity and Sensory Intactness in a Senescent Population.

CARL EISDORFER, *Duke University Medical Center, Durham.*

Problem: To investigate the relationship between visual and auditory deficit and Rorschach rigidity in an aged population. It was hypothesized that: 1) When visual decrement is presented but corrected no increase in rigidity on the Rorschach would be found; 2) When visual decrement is present but not corrected, an increase in Rorschach rigidity is expected; 3) When auditory decrement is present but uncorrected, rigidity as reflected by Rorschach signs will be found; 4) Subjects with both auditory and visual deficits will show a greater incidence of rigidity than subjects showing a decrement in either sense system alone.

Subjects: Forty-eight senescent (i.e., aged 60 and older) subjects were studied; all were volunteers for the research program of the Duke Geriatrics Project. Subjects were screened to eliminate those with neurologically definable CNS damage, and only those community volunteers with a Verbal I.Q. (WAIS or WBI) in the range 84-115 were included.

Procedure: Three levels of visual acuity (Snellen Chart examinations) and two levels of auditory functioning (pure tone audiometric examinations) served as the dimensions of a 3 x 2 design. Piotrowski's Alpha formula for Rorschach rigidity was employed.

Results and Conclusions: X^2 analysis for the incidence of S's showing Alpha score of + 3 or greater indicates that hearing decrement is associated with Rorschach rigidity ($P < .05$). Visual decrement accounted for relatively little difference in level of Rorschach functioning.

Longevity and Intellectual Variations in a Senescent Twin Population.

ARTHUR FALEK, FRANZ J. KALLMANN, AND LISSY F. JARVIK, *Department of Medical Genetics, New York State Psychiatric Institute, Columbia University.*

A longitudinal study of senescent twins (age 60 and over), organized in New York State in 1945, has been concerned with variations in length of life, state of health, and intellectual performance during senescence. The present report evaluates the survival trends in this population of 2038 one-egg and two-egg twins as observed during a 13-year follow-up period, with particular emphasis upon 6 specific longevity variations.

In the analysis of comparative longevity statistics, the following subgroups have to be considered: 1) twin pairs where both partners died after age 60; 2) twin pairs where only one partner survived to age 60; 3) twin pairs where one partner is still alive after the age of 60; and 4) twin pairs where both partners are still alive after the age of 60.

Longitudinal data on changing intellectual functions have been examined for 36 pairs (26 one-egg and 10 same-sex two-egg) and 7 single survivors of a group of 127 same-sex pairs selected from the total sample, who were tested originally between 1945 and 1949. Preliminary statistical analyses indicate that basic similarities in the intellectual functions measured persist in senescence for one-egg twin partners and continue to exceed those between two-egg twins. It is of further interest that those two-egg pairs where both partners were still available for testing after an 8-year interval showed the most marked similarities in scores on the original test rounds. An equally intriguing hypothesis derived from the results concerns the relationship between high test score levels and survival during the follow-up period.

On the whole, life span data have demonstrated the important role played by hereditary factors in longevity, while preliminary psychometric findings would seem to indicate that gene-specific intellectual variations remain manifest into a well-advanced age.

Principal Values of Leisure for Adults: A Factor Analysis.

KENNETH FEIGENBAUM AND ROBERT J. HAVIGHURST, *Committee on Human Development, The University of Chicago, Chicago.*

Information concerning the favorite leisure activity was obtained by interview from a sample of 234 men and women aged 40 to 70 in the Kansas City Study of Adult Life. The favorite leisure activity was rated by judges who read the interviews, on a set of 19 value variables, such as enjoyment, creativity, vitality, service, instrumental value, autonomy, relaxation from tension, etc. A factor analysis was performed on these ratings together with several demographic and adjustment variables. Five principal factors were found, which have been named as follows: Play or Sheer Pleasure; Challenging, Complex, Creative Experience; Solitary Useful; Women's Gregarious Instrumental Service; and Middle-Class Women's Passive Pleasure. These factors can be used to describe types of meaningful use of free time. There are characteristic leisure activities for each factor. Persons with high loadings on the various factors are described.

Health Status and Medical Costs of the Aged Population.

SIDNEY GOLDSTEIN, *Brown University, Providence.*

The belief that the financial difficulties of old age constitute a particularly acute problem in the area of medical care rests on the premise that the medical needs of older people are much greater than those of most other groups. Findings of the 1957-1958 National Health Survey document the disadvantageous health status of the aged compared to all younger segments of the population. Whether judged by average number of physician visits, by number of days of restricted activity and bed disability, by number of work-loss days per employed person, by number of days spent in the hospital, or by number of physical impairments, the aged occupy the poorest health level.

Coupled with the results from the most recent nationwide studies of consumer expenditures, these health data show that at a time when money income is at its lowest, the chances are greatest than an illness will set in which may be both prolonged in its physical effects and devastating in the financial losses which result. The poor health of the aged requires them to devote a higher percentage of their expenditures to medical purposes than do the units headed by a person under 65 years of age. Yet, the absolute amounts they spend are generally well below the outlays of younger units. This is so despite the fact that the aged expend relatively more for direct medical costs and relatively less for medical insurance than do younger units. These findings suggest that the lower income level of the aged may prevent them from expending as much on medical care as their needs warrant.

Work and Patterns of Retirement.

MARGARET S. GORDON, *Institute of Industrial Relations, University of California, Berkeley.*

Among the meaningful activities in which elderly persons may engage, remunerative work is losing ground in relative importance as the proportion of men aged 65 and over in the labor force declines. The 1950's have been characterized by an acceleration of this trend, by an impressive rise in public interest in policy issues affecting the employment of older persons, and by substantial progress toward developing the types of research that are needed to provide a sound basis for decisions on these issues.

Ten years ago it was widely assumed that many elderly persons who were not in the labor force would like to work and that compulsory retirement was the major obstacle standing in their way. We now recognize that the problem is far more complex and that ill health and lack of relevant skills keep many older people out of the labor force. We know that attitudes toward work and retirement vary greatly by occupation, as does the relationship between efficiency and age. We are accumulating useful information on experience under both compulsory and flexible retirement programs and are approaching the issue of retirement policy at a considerably more sophisticated level.

At the same time, social gerontologists are increasingly aware of the fact that an individual's capacity to engage successfully in either work or constructive leisure-time activity after age 65 depends on how he has adjusted to the social, psychological, and economic stresses of the

earlier adult years. If the victims of age barriers to employment, deteriorating health, or downward occupational mobility are becoming subjects of study, so also are the individuals who are paving the way to a frustrated old age because they are absorbed in work to the exclusion of all other interests.

Characteristics of Retired Migrants to St. Petersburg, Florida, 1940-1954.

WILLIAM H. HARLAN, *Department of Sociology, Ohio University, Athens.*

An area sample of 1034 dwelling units in St. Petersburg yielded demographic and other data regarding a representative group of 287 retired white males who had migrated to the community during the period 1940-1954, mainly after 1945. The data include: age, state of residence prior to migration, occupation prior to retirement, marital status, household composition and type of dwelling, and health condition. The age range was from 50 to 92 years. Approximately 50% came from the New England and Middle Atlantic states, and 30% from East North Central states, with the remainder widely scattered; more than half were from metropolitan communities. The major occupational categories were: professional and technical, managerial, self-employed, and protective service workers; there were few clerical or sales workers, craftsmen, farmers, or laborers. Four-fifths were married and living with wife in a single-family dwelling; widowed and single men had widely diversified living arrangements. Few instances of retirement and migration for reasons of health were encountered; nearly all classified their health condition as good. A chief finding of the study is the high degree of selectivity of the in-migration with regard to community of origin, occupation, marital status, and health condition. A preliminary report on the cost of living, activities, and personal adjustment of 135 of these men before and after migration is also presented, based upon data obtained through schedules and extended interviews.

Relationship of Activities and Attitudes to Physical Well-Being in Older People.

FRANCES C. JEFFERS AND CLAUDE R. NICHOLS, *Regional Center for the Study of Aging, Duke University, Durham.*

The present investigation is part of an interdisciplinary study at the Duke University Medical Center on the effects of aging on the central nervous system. Two days of examinations were conducted on a bi-racial group of 260 community volunteers over 60 years of age. These included intensive physical, psychological, and social evaluations.

Level of physical functioning was determined by a physician on a 6-point rating scale based on detailed physical and neurological studies and a medical history. Data on activities and attitudes were obtained through the inventory devised by Burgess, Cavan, and Havighurst.

Analyses of the data show a relationship between physical functional rating and total activity score. Individuals with no disability scored significantly higher on the activities scale than those with mild to severe disability. Similar relationships were obtained for several sub-sections of the activities scale: intimate contacts, leisure activities, security, health, and religious activities. The magnitude of the correlations varied according to sex, race, and socio-economic status.

On the other hand, physical functional rating was not significantly related to total attitudes score. Among the sub-sections of this scale, only religious attitudes were consistently related to physical function in the various subject groups. Individuals with physical disability tended to have greater strength of religious feeling. The discrepancy between the findings on the two scales will be discussed.

Role of Interests in Adjustments of Older People.

EDWARD S. JONES, *Center for Study of Aging, Duke University, Durham.*

In a study of interests and adjustments, data were collected mainly through questionnaires completed by psychology students regarding 210 grandparents over 65 years of age. In addition, 30 retired professional men in the Chapel Hill area were interviewed and evaluated on the basis of their responses to check lists concerning their past and present interests. Measures of adjustments included health (with psychosomatic items), evaluations of happiness and mental alertness as perceived by the family through responses to several questions.

In determining alertness and happiness, the value and strength of present functioning interests are more important than the backlog of past interests until after 80. Beyond 80 a narrowing of interests may not be detrimental to alertness or happiness. Older women (beyond 80) are significantly more unhappy and less alert than older men. The latter, after accepting lower status, tend to remain independent in their own homes. However, all inter-correlations between interests, health, happiness, and alertness are much higher for women than for men. This result may be due largely to the influence of education for the large percentage of women in this study who were housewives only. In men, employment (16% in the study were employed full time) also reduces outside interests. In the group of upper middle-class men, independence of thought and freedom from rigidities during and after childhood, plus the maintenance of a fair number of interests, seems to be more important than health and education in determining happy adjustment in retirement.

Leisure Activities and the Older Adult.

MAX KAPLAN, *Boston University School of Fine Arts, Boston.*

The need for classification of leisure activities will be discussed with reference to research applications. In addition the discussion will include such topics as the meaning of leisure activities, factors which influence their selection, the dynamics of activity, and its modification. An attempt will be made to relate the theory of leisure classification to applications by group workers, policy makers, and others.

Personality Changes in the Middle Years.

E. LOWELL KELLY, *University of Michigan, Ann Arbor.*

This is a report of measured personality changes in 200 men and women first tested as engaged couples between 1935 and 1938 and re-tested again in 1954. The average age at the first testing was 26.7 for the men and 24.7 for the women. As a group, the subjects were

somewhat above average in intelligence, education, and socio-economic status. Of the 85% reporting religious affiliation, 11% were Catholic and 8% Jewish.

The test battery included: the Allport Vernon Scale of Values, the Strong Vocation Interest Blank, the Bernreuter Personality Inventory, scales for measuring attitudes toward marriage, divorce, church, entertaining, housekeeping, and gardening, self-ratings on 36 personality variables, and opinions regarding conditions making for an ideal marriage. This battery yielded a total of 103 variables of which 38 were selected for intensive analysis.

A comparison of the mean scores at Time 1 and Time 2 revealed: 1) For 20 of the 38 variables, there was no significant change in mean score for either sex; 2) In the case of the 18 variables for which the mean change was statistically significant, the magnitude of the change was still relatively small; 3) These changes, although small, tend to be in the same direction for both sexes; 4) Even though small, each of the significant changes in means is of theoretical interest, but, in the absence of adequate age norms at the two points in time, may be equally well interpreted as due to increasing age or cultural change.

Scores on the same 38 variables were also analyzed with respect to intra-individual consistency over the 20-year time span. For all variables the test-retest correlations, while lower than those reported for shorter time intervals, were nonetheless highly significant. Values and Vocational interests were found to be the most stable variables, Attitudes the least stable. This analysis also revealed a tendency for persons scoring at the extremes of distributions at Time 1 to have moved more toward the mean of the group at Time 2 than would have been expected solely on the basis of statistical regression. This phenomenon is labeled Maturational regression.

Since these measured changes in personality were considerably greater than could be attributed to errors of measurement, an effort was made to identify correlates of changes on the personality variables. In general, such changes seem to be relatively specific and not related to identifiable characteristics of the subjects at the time of initial testing.

Age Differences in Status and Happiness of Workers.

H. MELTZER, *Orchard Paper Company and Washington University, St. Louis.*

That the later years are times of diminished happiness, diminished ambition, and increased worry is a stereotype in the minds of college students. To what extent, if any, is this applicable to workers as they age in a given industrial setting? Is age, as such, the determining factor?

The answers to these questions call for a knowledge about how workers of various ages think and feel about such basic attitudes as status and happiness. This study represents one attempt to obtain such knowledge by investigating the attitudes of 270 workers in one industrial setting. The total group was divided into 4 age groups. The statistical findings concerning age differences in attitudes about such life adjustment items as share of happiness, share of recognition, work enjoyment as against spare time, interest in advance as against interest in steady work are taken from a more comprehensive morale study where the focal point of interest was on work attitudes considered in terms of factors more relevant to actual job adjustments, such as attitude toward supervisors, satisfaction with work conditions, and similar items.

The statistically reliable differences are interpreted in the light of personality differences based on interview findings aimed to consider status as perceived by the workers and happiness as conceived by them. The particular industrial setting in which one works represents the opportunity for attaining the type of relative measure of satisfaction or notion of status and happiness depending on the fulfillment of expectancies. From results of a statistical study supplemented by clinical interviewing, some factual realities are reported which can, at least in part, replace the stereotypes about older workers that even educated people have at the present time.

Older Adults as Members of the Mass Audience.

ROLF MEYERSOHN, *University of Chicago.*

As people grow older they attend fewer movies, read fewer books and magazines, participate in fewer spectator activities, but their interest in television remains keen. While this discussion will emphasize television, what is said in this context will usually apply to the other mass media as well. The themes sketched out here represent hypotheses rather than findings and are presented to help build a framework for research in this area.

For the television industry older people constitute a very good viewing audience but a very poor buying audience. Because of the poor quality of older people as a market, the television industry concerns itself less with programming for older adults. However, since older people are not in most respects a clear-cut interest group, the researcher is hard put to say what kinds of programs, if any, are lacking as a result of this neglect.

Regardless of the neglect, older people constitute television's most grateful audience. It serves a number of useful functions: television provides parataxic companionship for the many who are alone; it is well suited to the sedentary patterns of older people; once the set is bought, television becomes relatively free. As a source of universal conversation and interest, it can act as a common denominator for young and old, who may otherwise have little to say to each other.

Ideally, television can provide ways of generating new interests and stimulating the viewer to develop and fulfill himself; however, there is little to indicate that this has been happening. Rather, television, without creating anything new, provides a most compelling way to spend time; it is therefore especially appreciated by those who no longer want to be left to their own devices.

A Study of Eighty-five Spanish-American War Veterans and Their Lifelong Environmental Adaptation as Related to Their Current Adjustment to the Aging Process.

MARGARET R. NICHOLS AND JAMES F. CUMMINS, *Veterans Administration Outpatient Clinic, Boston.*

The purpose of this study is to obtain information including both organismic variables and ecological fac-

tors as related to the mechanisms and etiology of aging. It is believed that the individual's lifelong capacity to adjust to stresses has predictive meaning as to his continuing ability to adapt to the natural aging process.

To date 85 normal non-institutionalized Spanish-American War veterans, average age 81, have been studied by Social Service. Because of the researcher's orientation and training, casework techniques were utilized within the longitudinal framework and casework services were first rendered when indicated. Consideration was given to the individual's defense mechanisms and needs ability to relate and recall. Because of these factors, timing was important and the completed sequence of interviews varied in quantity and quality.

General analysis indicates that the average clinic patient is a youthful octogenarian of Anglo-Saxon background, born in this country, still married, retired 13 years, economically secure and well enough to participate in changing family and community affairs. He has his own religious and philosophical code and interests. Background data reveal that he was exposed early to various vicissitudes. He completed 8 grades of school, entered the service for adventure, and made sound consistent occupational and marital choices.

The general impression is that the average clinic patient is a stable, conforming individual who, during his years, experienced only one severe stress at a time, and whether objective or not, views his lifetime positively. Continuing medical care and support is necessary for his survival.

The Senescent Electroencephalogram.

WALTER D. OBRIST AND EWALD W. BUSSE, *Center for the Study of Aging, Duke University Medical Center, Durham.*

A summary of EEG findings by the authors and their co-workers over the past 10 years is presented, based on more than 1200 elderly people. Many of the observations reported have been confirmed or made independently by other investigators here and abroad.

In healthy community and institutionalized subjects, the EEG undergoes definite but minor alterations with age. Compared with young adults, there is a slight shift of frequencies to the slow side, particulary the alpha rhythm. There is also a relatively high incidence (30%) of temporal lobe irregularities. These findings do not seem to be correlated with performance on intelligence, learning, or memory tests.

In aged psychiatric patients, on the other hand, EEG alterations are more pronounced, and there is a significant correlation with mental status. Diffuse slow activity (delta and theta) is associated with chronic or acute brain syndrome, the degree of slowing being related to the severity of intellectual deterioration and to prognosis.

Clinical evidence of advanced arteriosclerosis increases the probability of a slow EEG, suggesting a possible etiologic factor. Psychiatric patients with normal or low blood pressures have more diffuse slowing than do those with mild hypertension. It is speculated that an elevated blood pressure may compensate for increased vascular resistance in old age, thus tending to maintain cerebral circulation and preserve a youthful tracing.

Differences in Patterns of Drinking Among Individuals Over 60.

DAVID J. PITTMAN, *Washington University School of Medicine, St. Louis.*

Previous research investigations in both the fields of gerontology and alcohol studies have almost completely ignored the drinking behavior and pathology of individuals over 60 years of age. This study presents some basic information on the differential drinking patterns and pathology of three divergent groups of men and women drawn from two geographical areas of the country, namely Upstate New York and a metropolitan Middle Western community. The three groups from whom the samples have been drawn are: 1) a group of men who were incarcerated for public intoxication in a county jail; 2) Alcoholics Anonymous members; and 3) members of civic and recreational clubs who were assumed to be non-pathological drinkers. Data from the intoxication offenders were obtained by detailed structured interviews and from the last two groups by group administered questionnaires.

The drinking behavior of each group is analyzed in terms of the trichotomy of pathological drinker, social drinker, and non-drinker. Data are presented on first drinking experience, social context of drinking, alcohol preference, frequency of alcohol ingestion, and duration of drinking episode for each group. Differences and similarities in the drinking patterns of the three groups are abstracted.

In conclusion, hypotheses are presented to explain the social and psychological functions of drinking and non-drinking among these three groups of men and women over 60.

Methodological Problems Concerning Comparability of Utilization Data by the Aged of Hospitals.

WALTER POLNER, *Research Associate, Economic Department, American Medical Association, Chicago.*

The use of statistical data to measure the utilization of the short-term hospital by aged persons is fairly new. Although a great deal has been written about the rising utilization of the hospital by aged persons, a feeling of confusion still remains concerning conflicting utilization data in different studies. The basis for these contradictory statistics is inherent in how these data are collected.

Although the principles of sound social science research concerning the use of the hospital were well established by the 1950's, there are still impediments to gathering comparable hospital utilization data. One utilization statistic useful for one purpose may be of very little use elsewhere.

While each of the studies may have its special characteristics, some general causes for the differences are: a) different purposes in collecting data; b) practicality of research; c) interpretation of key methods by research workers; d) knowledge of local conditions; e) extent and content of voluntary health insurance coverage; f) inclusion or exclusion of the indigent aged; and g) type of data collected.

These available data show the need for careful adjustment of the published material before the data may be utilized by other research projects.

On Changes in Social Attitudes and Interests During Old Age.

KLAUS F. RIEGEL AND RUTH M. RIEGEL, *Department of Psychology, University of Michigan, Ann Arbor.*

A multivariate study on the process of aging was conducted during 1956 to 1958 in Hamburg, Germany. Three hundred and eighty persons of the age range between 55 and 80 years, as well as a control group of 120 subjects with a mean age of 17.9 years, were tested in Northern Germany. The sample was checked and compared with census data on 7 criteria: age, sex, profession, source of support, marital status, native/refugee, and religion.

Aside from measures of intellectual and verbal functioning and aside from an interview on the social background of the subjects, 4 personality scales have been applied, namely scales measuring rigidity, dogmatism, attitude toward life, and interests. The differentiation between rigidity and dogmatism follows that of Rokeach: rigidity refers to a preference for habituated behavior; dogmatism refers to an authoritarian and intolerant manner in which ideas and beliefs are communicated to others. The scale on the attitude toward life reveals an estimate of the subjects' life expectancies. In the interest scale the subjects indicate their preference for 14 different activities in which older persons may engage.

All 4 instruments have been screened in a pilot study. Item analyses and cluster analyses have been made, in order to obtain homogenous scales and the least overlap between the tests. Comparisons between the different age groups on the tests, as well as on the interest items, will be reported.

A New Technique for the Study of Institutions.

RAYFORD T. SAUCER AND NEIL W. COPPINGER, *Veterans Administration Center, Kecoughtan, Virginia.*

Institutional living is a primary area of interest to the gerontological scientist, but by the very nature of the process, direct question and answer interviews are apt to be less than rewarding. A technique devised by T. G. Andrews suggests an indirect method of studying the uncontaminated perceptual world of the member of the institution.

Andrews has related the methods of factor analysis to the problems of multidimensional psychophysics with the stated objective of obtaining an estimate of the number and nature of the psychological dimensions operative in a given situation. In so doing, he has derived a method of studying perceptual processes in which the perceptual dimensions of the observer, rather than the investigator, become the objective of the investigation.

In many ways, the technique resembles the projective technique, except that the data can be quantified and factor-analyzed. We have found that by the use of this technique we are able to determine some of the perceptual dimensions of an institution for older disabled persons. Since there was considerable disparity between our perceptual dimensions and those of the residents of the institutions, we believe that this method may be extremely provocative in studying the individual's perception of his immediate environment.

Critical Differences between Vocationally Well Adjusted, Rehabilitated, and Non-Rehabilitable Older Men.

ROBERT S. SOAR, F. ESTELLE BOOTH, AND SEBASTIAN TINE, *Senior Citizens Center, Nashville.*

The paper will outline the procedure and results of a two-year study of three groups of older men: a group maintaining good vocational adjustment without help, a group successfully rehabilitated, and applicants for OASI disability freeze judged not to be rehabilitable. The study has been sponsored by the Office of Vocational Rehabilitation, with the cooperation of the State Division of Vocational Rehabilitation. The aim of the study was two-fold: To identify critical differences between these three groups as an aid to administering rehabilitation services and to gather normative data on these representative groups from the community toward better understanding of the problems of the aging.

Among measures employed have been social, psychiatric, and medical status interviews, vocational histories, and tests of intelligence and personality. Differences between groups have been tested for statistical significance and the validity of each measure for discriminating between groups estimated.

Among the results to be discussed will be: 1) special difficulties in doing research with subjects, from the community of this socio-economic level; 2) general findings of the study in terms of statistically significant group differences; 3) implications of this study for future research.

Design of an Operational Research Project.

IRVING L. WEBBER, *University of South Florida and Pinellas County Health Department, St. Petersburg,* AND CARTER C. OSTERBIND, *University of Florida, Gainesville.*

A local public health department has undertaken a social survey to determine the health status and behavior of older people in a Florida county. This survey is part of an operational research program intended to contribute to developing a community health program for the aged.

This paper describes the research design and discusses the basis for utilizing a detailed schedule of questions that elicit information for a given period of time regarding health and health practices of a representative sample of residents aged 65 and over. Attention is given to the requirements of an operating health program as they bear on decisions made in shaping the research design. These relate to the manner in which the research program is to be implemented, the methods to be employed in evaluating existing programs, and the criteria to be employed in appraising the need for new programs. Various aspects of the research design as influenced by these particular considerations are examined.

Evaluating the Psychiatric Problems of Older Persons.

JAMES M. A. WEISS, *Department of Psychiatry and Neurology, Washington University School of Medicine, St. Louis.*

Because the nature of psychiatric disorder manifested by non-institutionalized older persons has never been clearly delineated, an attempt was made to analyze the

presenting problems described in clinical case records of 200 older patients referred to a metropolitan psychiatric clinic (as reported in an earlier paper). A major limitation in that approach, however, was the unavoidable distortion present in the records because of the selective perception of both patients and interviewers.

To decrease such distortion an original Psychiatric Evaluation Index (PEI) was developed as a new test instrument for gerontological research. The PEI is a balanced 70-item sample of empirically derived, representative psychiatric symptoms, signs, and complaints. Each subject is asked to distribute the 70 items in a quasi-normal Q-sort distribution ranking the items along a continuum of applicability. All items can then be classified qualitatively and quantitatively on a two-dimensional schedule, also empirically derived. The first dimension, the determinant, identifies the dominant or major characteristic of the item; the second dimension, the referent, identifies any situational factor which the subject relates in any way to the determinant.

Completed studies and investigations in progress indicate that the PEI has a high degree of reliability (internal consistency) and is both meaningful and useful in differentiating various types and degrees of psychiatric problems of older persons, in relating such problems to other concurrent variables (e.g., age, sex, diagnosis), and in formulating new theoretical constructs relative to the assessment of behavioral dysfunction associated with the aging process.

SECTION ON SOCIAL WELFARE

Abstracts edited by Jerome Kaplan.

Interdisciplinary Aspects of Contemporary Gerontological Rehabilitation as Demonstrated in Current Research-Demonstration Projects.

Participants: JOHN A. HACKLEY, *Supervisor, Rehabilitation Education Service, Illinois Public Aid Commission, Peoria.* VERA H. MCCORD, *Coordinator, Rehabilitation Education Service, Washington State Department of Health, Seattle.* BRUCE UNDERWOOD, *Consultant on Nursing Homes, Chronic Disease Programs, U. S. Public Health Service, Washington, D. C.*

This symposium covers organization, content, and methodology of two current research-demonstration projects in gerontological rehabilitation The first such programs of their kind in the United States, these projects provide graphic demonstration of the need for interdisciplinary cooperation in designing and undertaking rehabilitation services for older persons.

The Rehabilitation Education Service of the Illinois Public Aid Commission is a three-year research project which began in February, 1957. The Rehabilitation Education Service of the Washington State Department of Health is a 5-year research project started early in 1959. The directors of these two projects will discuss their respective programs in terms of the experience of each project and the implications of such experience which might affect projected planning in gerontological research and training. Educational approaches and social welfare aspects of gerontological rehabilitation will be key considerations in the discussions.

In conclusion, Dr. Underwood will discuss the need for local, state, and regional training programs so as to stimulate the development of comprehensive rehabilitation services in the various types of facilities serving the chronically ill, disabled, and aged. The effective utilization and coordination of all related resources to facilitate adequate programming on the local and state level will be the basic consideration in Dr. Underwood's presentation.

The symposium will illustrate the role of the professions, the areas in which they operate, the findings which suggest both services' tends for the future and needed additional research, and the kinds of training indicated in order to provide gerontological rehabilitation.

The Aging Negro: Some Implications for Social Welfare Services.

W. M. BEATTIE, JR., *Planning Director, Services to the Aging, Health and Welfare Council of Metropolitan St. Louis.*

Questions may be raised as to whether the patterns of health, welfare, and leisure-time services for our aging population which are emerging throughout the United States have relevance or meaning for the aging Negro. The growing body of knowledge in social gerontology and the development of services to meet the specialized needs of the older population based on that knowledge have not taken into account what differences, if any, may exist in the various racial and ethnic groups which comprise our aging population. Such knowledge is essential, especially for the larger metropolis, where evidence points to the growing concentration of both the aged and the Negro in the zones of transition. More specifically, the question might be raised as to whether contemporary planning in social gerontology has meaning for the older Negro and his family.

A few possible dissimilarities between the aged white and Negro which should be considered when developing social welfare programs include: differential concepts of the meaning of old age; patterns of family relationships and responsibilities, especially in regard to the older person; the point at which age becomes a barrier to employment or reemployment for both groups; differentials in income maintenance; and, the availability and use of institutional and agency services and facilities.

Some of the existing and emerging social welfare services may have little relevance for a large segment of the older Negro population. Is the majority of Negro housing suitable for home care programs? Do alternatives to institutional care, such as foster home placements, have applicability for the aged Negro? Are the protective services of the community available to the older Negro?

This paper will attempt to evaluate what knowledge we have as well as to suggest what knowledge we need in order to develop appropriate social welfare services for the aging Negro.

Group Counseling with Older Hospital Patients.

MURRAY G. BERMAN, *Supervisory Clinical Social Worker, Veterans Administration Hospital, Minneapolis.*

Hospitalization is frequently the point at which a patient already facing complex adjustments to aging confronts additional problems superimposed by his medical situation. Often this involves arriving at crucial adjustments in his total life situation. The extent to which he can adequately handle both facts and feelings about aging, illness, and limitations influences how he responds to treatment and how well he maintains himself following hospital discharge. Participating in a patient peer-group focused on these areas can substantially assist the older patient in arriving at the best adjustment for his individual situation.

As an integral part of the total medical treatment program, physicians prescribe for selected patients attendance at the one-hour daily Senior Veterans Group sessions. The medical sanction of the significance of the patient's total social-emotional adjustment for his medical situation is a vital ingredient in the benefits patients derive from participating in the program. Initiated and developed by the author as a social groupwork program of the hospital's Social Work Service, the Group has served over 300 patients in the two years of its existence.

Staff from various hospital services attend as resource people, providing information to stimulate patient discussion in such areas as health, finances, employment, leisure time, and general social adjustment. Involvement in the group process furthers the patient's ability to integrate and utilize the information and ideas discussed. In some instances, it is primarily the socialization experience itself which is crucial in effecting the patient's better hospital and post-hospital adjustment. This is related to reduction of tensions through group support in the hospital and subsequent incentive to seek similar satisfactions after hospital discharge through involvement in group activities in the community.

A further, although indirect, benefit of the program to patients is that it serves to stimulate the development of geriatric focus in the programs of other hospital services and related community resources.

Report of a Sample of 1,200 Households in Albany County, New York, and Its Service Implications.

JEAN K. BOEK, SARA R. HARRIS, WALTER BOEK, AND RAYMOND HARRIS, *Center for the Study of Aging, Inc., Albany.*

This paper will present the methods used and the data obtained in a study of 1200 households to determine the residence patterns, health and illness, employment, and social security status of 400 individuals 50 years of age and over residing in Albany County, New York.

An I.B.M. card with items such as name, address, age, sex, was punched for each person in 1200 households. Additional questions as to illness, employment, and job seeking were included for all individuals 50 and over.

The procedure for setting up the sample will be outlined as it demonstrates how an accurate and fairly large sample within a political region, namely a county, can be put into operation on a minimal budget through utilization of available resources, voluntary and governmental agencies, and senior citizens, themselves.

This sample will be the basis for further community health and welfare studies. Specific questions will ascertain for individuals 60 years of age and over 1) their knowledge of, need for, and use of community facilities; 2) medical and dental care received during the past year or 6 months; and 3) measures of social status such as level of living, schooling, or present or past occupation. The research findings will suggest and reflect on the current techniques of reaching older people, the services required by older people in the above areas, and the use of services now available.

The Senior Citizens Center as a Therapeutic Community.

ESTELLE BOOTH, JOSEPH R. MOORE, SEBASTIAN TINE, GRACE MCCONNELL, AND SOPHIA DEUTSCHBERGER, *Senior Citizens, Incorporated, Nashville.*

A coordinated team approach of groupworkers, caseworker and nurse on the staff of multiple service Senior Citizens Center, plus the therapeutic atmosphere created by the presence of a preponderance of healthy members of the Center, have been found effective in helping those older persons whose personality difficulties interfere with their ability to cope with social situations. This paper will describe the experience of this demonstration project to date, including the types of personal problems encountered, the groupwork and casework methods used, the role of the nurse and the influence of other aspects of the Center program, such as administration. Cases illustrative of the principles involved will be discussed.

New Frontiers in Japan for Training in Gerontology.

GEORGENE E. BOWEN, *Director, Education-Recreation for Older People, Health and Welfare Council, Philadelphia.*

The Ninth International Conference of Social Work meeting in Japan late in 1958 chose as its theme, Mobilizing Resources for Social Needs. It offered an opportunity to throw the spotlight on the urgent social needs of the Japanese aged.

A plan for training institutes for workers in the welfare field was therefore devised by a joint committee of representatives from the National Council of Social Welfare, the Ministry of Welfare, and the Gerontological Society of Japan. Their plan provided for two-day institutes in the 6 prefectural centers of Tokyo, Shizuoka, Osaka, Okayama, Matsuyama, and Fukuoka. Among the workers invited were staff of prefectural and local councils. governmental agencies, volunteer Minsein, Buddhist and Christian workers, superintendents of homes for the aged, educators, and medical leaders.

The training program, carried out over a two-month period, reached over 1200 participants, who heard lectures on health, housing, and psychological problems of the aged. Major emphasis was given to development of recreation clubs and enrichment of their programs. The use of volunteers and new program ideas were described. One session was devoted to demonstration and teaching of suitable play party games. Translated pamphlets were distributed on organization and use of citizen volunteers. A book of games was prepared for workers' use.

It was the consensus of the Committee that the goal of the training program had been achieved. Given at

the right time and carried out in the right manner, it gave Japanese workers encouragement and help in developing their recreation services for the aged. Motion pictures, slides, and a tape recording will help to illustrate the findings.

Residents of Homes for the Aged. A Profile.

FRANZ GOLDMANN, *Director, Health Study, Council of Jewish Federations and Welfare Funds, Inc., New York.*

Findings from an intensive study of 530 residents of 5 Jewish homes for the aged in 5 different communities permit the presentation of a composite picture of the home population in 1958. The median age of the residents was 80 years, women far outnumbered men, the great majority of the residents were widowed, and all but one-sixth were depending for their support on public assistance. Old Age and Survivors' Insurance, or both. By the time of the study three in every 10 residents had been living in the home 5 years or longer. The great majority were suffering from physical or mental infirmity or from chronic illness, multiple health conditions being the rule. Close to one-half of all residents studied required care in special units for the sick. Mental impairment was widespread and mental confusion, ranging from milder forms to serious disturbance, was found in more than 40% of all residents.

These and a number of additional observations furnish clear evidence of the profound change in the character of the home populations that has occurred in recent years. In response to the new situation almost all the Jewish homes for the aged have developed into important resources for the long-term medical and nursing care of elderly people with chronic illness or permanent disability and they have come to play a significant role in the care of mentally impaired oldsters. There is good reason to assume that the findings of the study portray the situation in numerous other homes for the aged, regardless of auspices.

Public Housing for the Elderly in Chicago.

BERNARD KAPLAN, *Supervisor, Community and Tenant Relations,* AND WILLIAM HAMMOND, *Assistant Manager, Ickes-Prairie-Archer Housing Project, Chicago Housing Authority, Chicago.*

The paper will review some experiences of the Chicago Housing Authority in housing elderly families. Narrative and historical in form and content, it will show the growth in understanding and planning for the special needs of elderly. It will examine the changing assumption of public housing responsibility in Chicago toward housing the elderly as a special group with a distinct complex of economic, health, social, and psychological needs. It will emphasize that the experiences of the Chicago Housing Authority are important for what they tell us of successfully meeting needs and certain approaches where limitations suggest that there would be no useful purpose in repeating them here or in other similar urban settings. Whether as planned program or as pragmatic policy, each experience is part of a series of social experiments which can make good foresight the heir of wise hindsight.

Public housing in Chicago has moved in the last 20 years from providing apartments for the elderly within existing facilities as virtually an afterthought to housing designed and planned exclusively for the elderly, as exemplified by the Julia Lathrop Homes. In addition to the medical and social services which were gradually added in the former, specialized housing for the elderly now includes space for community use, rooftop solarium, clinic area, and a sheltered workshop.

Current economics and population trends seem to indicate that public housing may have to assume a larger share of responsibility for providing adequate, low-income housing for elderly and leisure time, health, and other agencies will need to participate in planning and program.

Some Implications of Sociological Theory for Gerontological Practice.

ANTHONY LENZER, *Michigan Legislative Advisory Council on Problems of the Aging, Ann Arbor.*

Sociologists have formulated theoretical statements with regard to the nature of age and sex roles and the mechanisms used to facilitate transition from one social role to another. Testable propositions about the behavior of older persons can be derived from these statements. Such propositions are of particular significance for social workers, administrators, and others responsible for the day-to-day operation of programs for older people. Sociological theory is seen as offering especially valuable suggestions with regard to the factors underlying attempts by the elderly person to resist or ignore efforts to help him with his problems. The basic sociological questions are: How is the role of the aged defined in contemporary society? How much prestige is attached to this role? What social mechanisms are available to ease the transition from middle life to old age? The important practical problems are: perception and acceptance of the self as aged; ability of the older person to identify with others in the same category and to work with them for the benefit of the older group; willingness of the elderly to utilize services and facilities created for them. The importance of greater involvement of the aged in the planning and operation of programs for this group is examined.

A Study in the Motivation and Interrelationships of Patient and Staff.

SAMUEL LISSITZ, *Sheltering Oaks Hospital, Cincinnati.*

Purpose of the Investigation: a) to analyse the experiences with more than 800 hospitalized aged patients during the past 5 years and develop guiding principles of motivation of patients for staff training; b) to study the personalities and motivation of the aged patients and the gradation of relationships with staff members in order to develop hospital patient-centered organization; and, c) to demonstrate how the families and the community forces influence the patient, staff, and hospital environment and organization and prepare a program of integrating these forces in the hospital's patient motivation program.

General Methods and Material: a) establish yardsticks of patient motivation and in this light study medical, nursing, social service, and other department records; study also volunteers' records and notes of family committees; b) depth interview selected sample of patients and personnel and thus learn of the circular process of interrelationships; c) consult with family doctors, resident physicians, and the attending medical staff

and learn how physicians' attitudes and medical management influence motivation; d) interview families and record the many types of family-patient relationships affecting the patient during hospitalization; and, e) extract lessons and principles of motivation from the records of successfully and unsuccessfully managed and treated patients.

Conclusions and Implications: a) to develop some guiding principles for the training of the staff in establishing effective patient relations within a geriatric hospital; b) to evolve some yardsticks of an effective pattern of motivation of staff within a patient-centered organization; and, c) to construct a program of integration of family-patient-staff through hospital education and planned participation.

Political, Social, and Welfare Impact of Plant Shut-Down on Re-employment Experiences of Older Workers.

HAROLD L. SHEPPARD, *Research Director, U. S. Senate Subcommittee on Problems of the Aged and Aging, Washington D. C.; on leave, Wayne State University, Detroit.*

Description of the purpose and nature of study undertaken will be described and the reasons for plant shut-down such as technological change, financial straits of small manufacturers, and decentralization will be discussed. The relationship of age, skill, and race to job-finding is presented and the social-psychological aspects of this phenomena is dealt with. The paper concludes with policy implications to the political, social, and welfare climate of the community.

The paper is based on a 1957-1959 study, financed by the Institute of Labor and Industrial Relations of the University of Michigan - Wayne State University, of 500 workers laid off by shut-down of the Packard Motor Plant in Detroit, June, 1956; 90% of the sample was over the age of 40. Data are presented dealing with re-employment and financial consequences, as well as the relationship of these experiences to the workers' political, social, and personal attitudes.

Dimensions of the Community of the Older Individual.

WALTER K. VIVRET, *School of Architecture, University of Minnesota, Minneapolis.*

Current literature reports in some detail the measure of the individual—his levels of activity and participation, and his adjustment. Seldom does it include the dimensions of the individual setting, or the range of contacts in that setting.

An interview-survey of 133 older people in Minneapolis - St. Paul is examined in terms of the dimensions of the community in which the individuals lived and moved: the frequency of specific contacts, and the distance and mode of travel. The findings suggest that a realistic appraisal of the community of the older individual, particularly in urban areas, might substantially alter some of the popular notions about accessibility and availability of facilities and services, and about integration and isolation in old age.

An Investigation of the Nursing and Personal Care Needs of Older Patients in Nursing-Facilities in Relation to Selected Characteristics of the Facilities.

KENTON E. WINTER, *Bureau of Public Health Economics, School of Public Health, University of Michigan, Ann Arbor.*

The purpose of this study is to investigate the relationship between the need for nursing and personal care of patients aged 65 and over in nursing-home type facilities and selected attributes of the facility which indicate its capacity to provide such care.

Particular nursing and personal services are classified in terms of the level of nursing supervision and staff required to provide them. On the basis of data obtained on ambulatory status, care, dietary needs, and other factors pertaining to need for nursing and personal services, the patient-group in each nursing-facility is classified in terms indicating the scope of patient need. Relationships between patient need for services and certain characteristics of the facility are then investigated. Facility characteristics include formal training and experience of supervisory personnel, patient-personnel ratio, type of arrangements for continuing medical care, and source of patients, with particular reference to admission following hospital discharge.

The data used in this analysis were obtained from an inventory of the 547 licensed or approved proprietary, non-profit, and county-operated nursing-home type facilities in operation during the first quarter of 1957 in Michigan. In each facility a one-day census of patients was also taken which yielded about 15,000 patients over 65 years of age.

GENERAL MEMBER DIVISION

Abstracts edited by Herbert Shore.

Experience of a Volunteer Staffed State Commission on Aging.

MORTON LEEDS, *Indiana State Commission on the Aging and Aged, Indianapolis.*

The Indiana Commission on Aging in 1955 began its organization to meet the problems of aging with an unusual blend of professionals working as volunteers in the Commission activity, including adult educators, political figures, personnel directors, social workers, physicians, ministers, and housewives. A 100-man advisory committee was drawn together and then reorganized into regional topic committees. With no budget at first, in 4 years the group worked up to $15,000 per year. County organization was started in 25 of 92 counties, and 4 full-time professionals now are employed in as many counties.

Hearings, surveys, and conferences produced a wide range of working materials, which have been organized into an exhibit of 18 booklets and a book employed in the community organization process. Three universities and a teachers' college are cooperating; multiple research is proceeding, including a massive community study of

an entire county, under university, health, and business sponsorship. State government is helping, especially health and welfare departments, in assigning personnel in the organization process.

The interim result, a ferment of ideas and action in retirement, institutional care, health, community organization, legislation, recreation, and housing can be essentially credited to an identification by the Commission members of professional aims with those of the community. A profound sense of common purpose, of individual role within the group, of personal responsibility for each area of specialization—these have contributed to a major step forward in one state's attack on the multifold problems of aging in our society.

Specialists and Citizens: Some Dilemmas in the Planning of Programs for the Aging.

ANTHONY LENZER, *Michigan Legislative Advisory Council on Problems of the Aging, Ann Arbor.*

Aging is rapidly acquiring the status of a professional field and a scientific discipline. Development of large-scale programs requires recruitment of trained administrators and other specialists, while costly, long-term research projects are being carried out by workers in many scientific fields. Besides these specialists on aging, however, many lay persons are attracted to this field. Laymen serve on almost all of the bodies which plan and develop activities for the elderly. This paper deals with some of the problems which arise out of the interaction of specialists and non-specialists in the planning of programs for the aging and with the contributions which each may make.

The layman's contribution is viewed, in part, as a function of his very lack of expertise in gerontology and his potential ability to take a broader view of the needs of the community and of the aging than may be possible for the specialist. One aspect of this wider outlook is an interest in the cost as well as the benefits of proposed programs and a concern with the allocation of social resources among various groups needing assistance. In addition the role of the lay person in questioning the value system underlying programs for the aging is discussed and the importance of this function noted.

Senior Citizens and Golden Age Clubs: What Kind of a National Organization?

ANTHONY SALAMONE, *Director Adult Education, St. Louis University, St. Louis.*

Many centers for Senior Citizens, Golden Agers, Fifty Plus, and Sixty Plus, in other words, centers to meet the recreational and social needs of our older population are opening in practically every city and hamlet in the United States.

Many of these groups, now well organized, are beginning to realize the importance of organization. To this end many are looking forward to organizing a national organization of Golden Age and Senior Citizens Clubs.

Three annual conventions have been held by many of these clubs at three different cities in the past three years, and many clubs in the United States have written for information on how they can join.

No doubt many unscrupulous persons will be seeking leadership of this type of organization for personal gain. An organization of over 15,000,000 persons over 50 years of age can be a very powerful deciding factor in elections and legislation. At $1.00 a year for dues, it would mean a better than $15,000,000.00 organization. A publication of their own with 15,000,000 circulation would bring in millions more in revenue from advertisements.

What kind of a national organization? This paper will deal with this movement and what professional persons in the field of gerontology can do to help guide our older population in the proper type of national organization.

Developing Community Responsibility for Problems of the Aging. Nashville Senior Citizens Center.

SEBASTIAN TINE, *Nashville.*

In 1956 the Tennessee State Department of Mental Health inaugurated a project to study the community status and needs of the aging. Out of this project has emerged a demonstration community center for senior citizens in Nashville, with emphasis on community education, direct services to individuals and groups, and research and training. This paper will outline the methods and processes employed by this department in stimulating local and state-wide groups into taking action on problems of the aging. The underlying assumption of the department is that the sociological aspects of our community attitudes of values and organization are an important contributing factor to the problems of our aging population. The focus of the department's efforts has been to stimulate thinking at the local community level as the first step in meeting the challenge of increasing mental illness among our senior citizens.

The thesis to be presented is that a public agency has a responsibility to give direction and assistance to local communities on a problem which it feels must be acted upon at once.

The presentation will cover the following points: 1) Defining the role of a state governmental agency in the aging field; 2) Developing cooperative relationships with local groups; 3) Selecting and development of local lay leadership.

The various functions and services of the Nashville Senior Citizens Center will be outlined and discussed.

The methods used to transmit the knowledge gained in the Nashville Center to other Tennessee Communities will also be discussed.

A Review of Progress in Cleveland with Programs for the Aging.

PAUL A. WILSON, *Vocational Guidance Bureau, Cleveland.*

This paper deals with the different attempts made in the Cleveland Community to cope with the problems of the aging. It not only reviews briefly what has been reported in recent years but also cites the more recent developments in the fields of recreation, housing, adult education, and counseling, thus bringing the Cleveland picture as nearly up-to-date as possible. It closes with a number of examples of older persons who have been successfully counseled into satisfying occupations.

TECHNICAL EXHIBITS

Abstracts edited by Leo Gitman, M.D.

S. J. Tutag & Co.

Geritag will be featured. Recent publications have attested to the advantage and efficacy of the 20 to 1 ratio of androgen to estrogen in the treatment of the ever-present problem of aging. Geritag formula embodies this very relationship plus a vital range of 9 vitamins, 10 minerals, Rutin, and 3 lipotropic agents.

University of Michigan Press.

Recent books by Wilma Donahue, Clark Tibbitts, and other well-known gerontologists will be displayed. The very readable books in the Ann Arbor Science Library will also be shown, along with highlights from the whole fall list. A representative of the Press will be on hand to answer questions and take orders.

SCIENTIFIC EXHIBITS

Abstracts edited by Leo Gitman, M.D.

The Center for the Study of Aging, Duke University, Durham.

E. W. Busse and R. H. Dovenmuehle, *Center for the Study of Aging, Duke University, Durham.*

The exhibit presents the purposes, financial and policy structure, and research activities of the Regional Center for the Study of Aging at the Duke University. Brief descriptions of the areas of research as well as the titles of specific projects and the investigators responsible are included. Literature available at the exhibit will more fully describe the particular research activities.

Electrovasography: Quantitative Diagnosis of Vascular Disorders.

L. Cohen, *Sinai Hospital of Detroit.*

An improved plethysmographic procedure which has been found useful in the management of patients having peripheral vascular disorders will be presented.

The method provides quantitative standardized records under physiologic conditions which demonstrate a) functional and organic components of vascular impairment, b) selection of patients for lumbar sympathectomy, c) extent of collateral circulation, d) location of obstructions in the arterial system, e) the effect of various therapeutic agents on peripheral blood flow, and f) individual sensitivity to tobacco.

The technic is relatively rapid, reliable, and acceptable to the patient in his home, in the physician's office, in the hospital ward. or in the operating room.

The Intra-Mucosal Insert: A Method for Stabilizing Dentures.

A. N. Cranin, *Brooklyn.*

Enlarged Kodachrome transparencies which depict the relatively new procedure of stabilizing artificial dentures using intramucosal inserts will be displayed. The various phases of case selection, diagnosis, treatment planning, operative and prosthetic techniques, post-operative care, follow-up and trouble shooting will be depicted pictorially. There will also be demonstrations of the instruments (newly devised) and their use. The method and procedure enables many aged patients to improve their nutritional status via the modality of utilizing denture prostheses which they ordinarily might be unable to use.

Programs for Aging in Metropolitan Detroit, United Community Services.

The exhibit will interpret the work of the local committee in community planning for aging; research, consultation, public education, and program education.

Relationship of the Menopause to Periodontal Disease.

R. T. Dudley, H. Elrick, W. H. Hiatt, F. Metz, and D. H. Mitchel, *Veterans Administration Hospital, and University of Colorado School of Medicine, Denver.*

This exhibit describes an investigation of the relationship of the menopause to periodontal disease. Clinical impressions suggest that rapid, unexplainable deterioration of dentition occurs in some post-menopausal women, especially those who have had an artificial menopause. The objective of the study is to determine whether there is a relationship between ovarian function and periodontal disease comparable to the situation seen in post-menopausal osteoporosis.

The study is divided into two parts which are in progress concurrently. One part is a survey of two large comparable (in age and economic status) groups of women. One group will be castrates, the other non-castrates. The two groups will be compared from the standpoint of dentition.

The second part of the project consists of a double blind study of 20 young castrated women. Half are receiving premarin, the other half placebos. All are being studied at regular intervals (q/6 months) by extensive medical, dental, radiological, and laboratory examinations.

Visiting Nurse Association of Metropolitan Detroit.

There will be a standing three-section cardboard poster with pictures of actual care being given to patients by a nurse, physical therapist, occupational therapist, and a home aide.

The Visiting Nurse Association of Metropolitan Detroit has a daily census of over 600 patients who are 65 years of age and over. A recent poll of their source of medical care indicated that 87% were under private phyicians' care, 63% had restrictions on their mobility, and 11% had been under Visiting Nurse care for 5 years and over. A high percentage of the older aged patients do improve and are able to become self-sufficient with the assistance of their family.

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National Institutes of Health
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(Alphabetical)

August 1, 1959

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FC—Fellow, Clinical Medicine
FP—Fellow, Psychological and Social Sciences
FS—Fellow, Social Welfare

MB—Member, Biological Sciences
MC—Member, Clinical Medicine
MP—Member, Psychological and Social Sciences
MS—Member, Social Welfare

G—General Division

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INDEX TO CURRENT PERIODICAL LITERATURE

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THE SUBJECT categories are those in *A Classified Bibliography of Gerontology and Geriatrics* by Nathan W. Shock published by Stanford University Press, Stanford, California (1951). Only major headings are used and the Roman numerals correspond to those given in the bibliography. In so far as possible, references are classified according to organ systems. Thus, most of the material on Geriatrics will be found under the organ system involved in the disease. Cross references are indicated by number at the end of each section. When available, abstract references are given *(B.A.—Biological Abstracts, P.A.—Psychological Abstracts,* and *P.I.—Population Index).* Abbreviations for journals are those used in *A World List of Scientific Periodicals Published in the years 1900-1933, 2nd Edition.* For journals not listed, abbreviations were devised according to the general rules used in the above source. It is impossible to cover all journals and list all papers concerned with aging and the age. Authors and publishers are requested to call attention to publications or to send reprints to the Gerontology Branch, Baltimore City Hospitals, Baltimore 24, Maryland. The assistance of the Forest Park Foundation, Peoria, Illinois, in the preparation of these materials is gratefully acknowledged.

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Published on a grant from the Forest Park Foundation to the JOURNAL OF GERONTOLOGY.

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